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Power In a Petroleum Refinery

STEAM CARRIED TO ENGINES LOCATED ½ MI. FROM BOILER PLANT; JACKETED BREECHING RESULTS IN HIGHER BOILER ROOM TEMPERATURE AND INCREASED ECONOMY

LOCATED ALONG THE southwestern shore of Lake Michigan and about 22 miles from Chicago is the city of Whiting, Ind., which, with its population of nearly 6000, lays just claim to having within its corporate limits, the largest petroleum refinery of the Standard Oil Co., of Indiana. As its neighbor, the City of Gary, has been built up around the great mills of the steel trust, so has Whiting been created and is practically maintained by this gigantic oil industry.

In order to minimize the handling of the fuel and ash, the boilers and all accessory equipment have been housed in a 3-story steel and concrete structure, with 6 500-hp. Vogt water-tube boilers occupying the third floor, the elevating and conveying machinery and ash hoppers the second floor, while the boiler feed and heater supply pumps and employes' lockers are found on the ground floor.

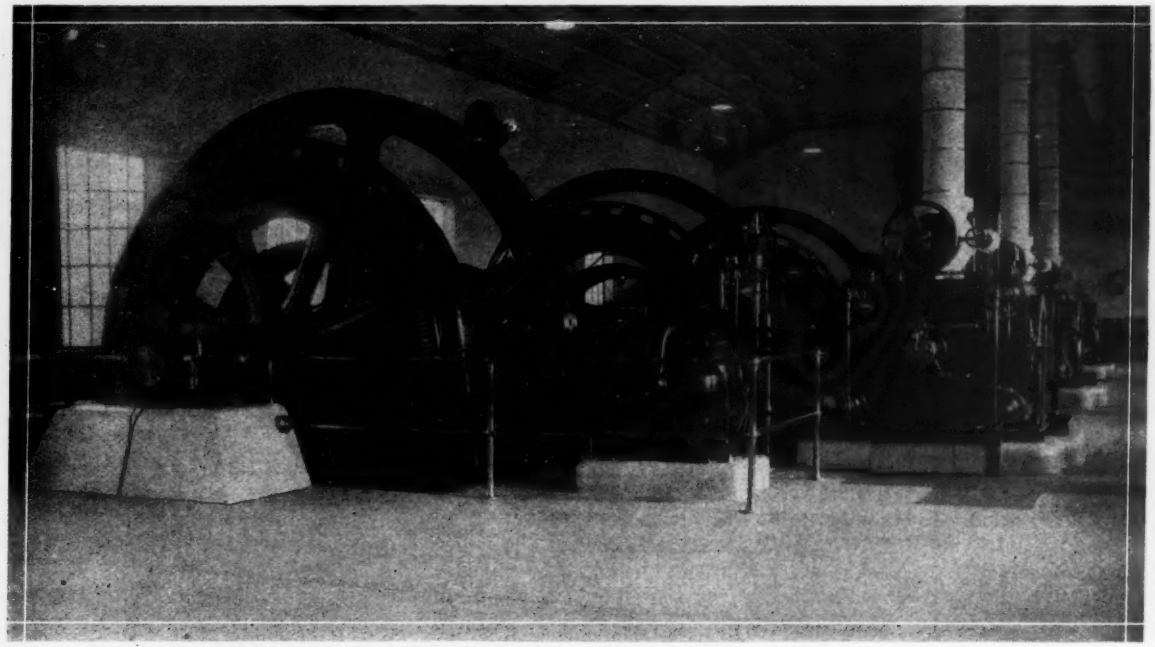


FIG. 1. GENERAL VIEW OF ENGINE ROOM, WHITING, IND., PLANT OF THE STANDARD OIL CO.

Since steam plays an important role in the various processes of refining, it becomes necessary to pay particular attention to its generation and transmission, and in order to maintain that high degree of efficiency and economy of operation so prevalent in all departments of the Standard Oil Co., a new and modern boiler plant was recently erected, and placed in operation on the first day of July, 1914.

Coal is received at the plant directly from gondola cars, dumped into a pit and by means of a bucket conveying and elevating system, manufactured by the Link Belt Co., is carried to the overhead steel bunkers fitted with cylindrical hoppers having conical bottoms. From

here it is fed as required, through fan-shaped ducts, to the stoker hoppers and then to the traveling chain grates. The ashes, dumped at the rear end of the boiler setting, fall into brick lined hoppers, where they are sprayed with a steam jet, to moisten them, and then fed through chutes into cars below to be taken away.

As stated above, the first floor contains the pumping equipment of the boiler house, which in this case consists of 6 National Transit duplex pumps. Two of these are used as boiler feeders, each having sufficient capacity to supply all of the boilers with feed water when working at 200 per cent of their rating, while 2 others, next in size, are used to maintain the heater supply. The last 2, the smallest of the group, are held in reserve to be used at any time it becomes necessary, due to a shortage of coal, to operate the furnaces with fuel oil. All piping is in place and should it become necessary, the change from coal to oil can be made in a comparatively short time by minor changes in furnace settings, and the installation of the burners.

temperature, and, by means of tests conducted for that purpose it was further found that when the jacketed breeching was in use, a saving of over 1½ per cent in fuel consumption could be effected, as compared with that when this source of air supply was cut off.

Operation of Boiler Plant

Exhaust steam from the power plant and the various stills is returned to a large open feed water heater designed and constructed by the company's engineering department and located outside of and adjacent to the boiler house. Due to the slight pressure carried on all exhaust steam lines, the water fed to the boilers, which is made up of condensate and that pumped from Lake Michigan, is preheated to an average temperature of approximately 217 deg. F. This temperature, like the steam pressure, is recorded by Bristol recording thermometers.

Periodical evaporation tests are made on the separate boilers and on the plant as a whole, and from results

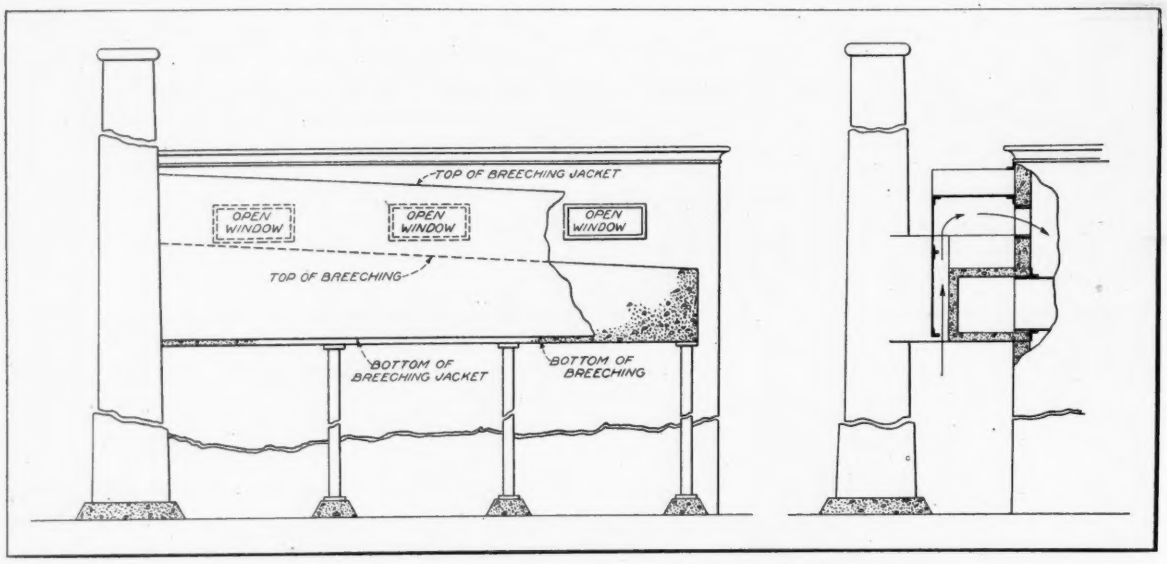


FIG. 2. LONGITUDINAL AND SECTIONAL VIEWS OF JACKETED BREECHING

Adjacent to the boiler house is a 250-ft. reinforced concrete stack connected to the boilers by means of breeching made of the same material.

It was found that when depending upon the natural openings of the boiler house to supply the air required for the furnaces, that during the winter months the temperature of the room became so low as to make it most uncomfortable. To eliminate this disagreeable feature, and with the hope of being able to increase the economy of the plant, a steel jacket was constructed around the breeching, as shown in Fig. 2. By referring to this illustration, it may readily be seen that by removing the windows above the breeching, a continuous circulation of air was created by being drawn up from the outside, around the breeching, thereby heating it, and then passing through the open windows into the boiler room. When in operation, it was found that the temperature of the boiler room could be raised as much as 50 deg. F. above what it had been with the same outside

obtained it is found, under existing conditions, with the fuel used, feed water at a temperature of 217 deg. F., and a steam pressure of 80 lb. gage, that an efficiency of 75 per cent was obtained when working the boilers at about 200 per cent of their rated capacity. This, with the proper supply of air, calls for a furnace temperature of about 2300 deg. F., and according to the records of a Simmance-Abady CO_2 recorder connected to the last pass of the boilers, an average of 13½ per cent of CO_2 is maintained.

When conducting tests, Blonck efficiency meters, Gebhart steam flow meters, Simmance-Abady CO_2 recorders and Hoskins pyrometers are used.

All boilers feed into an 18-in. steam header which, in turn, connects through a line of the same size to a 12-in. steam loop having a total length of approximately 2 miles and carried in well insulated underground conduit, with branches of required size leading to the various stills and the power plant.

Feed Water Heater Supply Control

Due to the fact that the feed water heater is of the open type and one constructed in the company's shop, it became necessary to provide a ready means of controlling the supply of water fed into the heater. As stated above, 2 National Transit duplex pumps, one for regular service, the other as an emergency unit, are used for this work.

On the wall of the ground floor of the boiler house, and connected to the water space of the heater by means of suitable piping, as shown in Fig. 5, are a gage glass and a float valve, the former indicating the level of the water in the heater and the latter operating a wing valve in the steam line of the heater-supply pumps. With the water at a low level, the float is in such a position that the connecting arm opens the steam valve, setting the pump in motion, and thereby supplying water

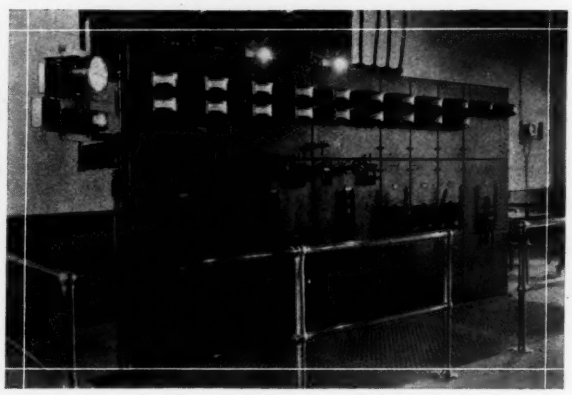


FIG. 3. SWITCHBOARD OF 3 GENERATOR AND 4 FEEDER PANELS

to the heater. As the level of the water rises, the steam supply to the pump through the medium of the float and wing valve, is gradually cut off until the water again lowers.

As a further aid to the boiler room operators, this float valve, by means of brushes and a sliding contact, is electrically connected to a bank of 5 lamps on the wall of the boiler room so that, as the float rises, and falls the lamps connected to the various points of travel of the float are cut into and out of circuit, thus indicating to the water tenders the approximate quantity of water contained in the heater.

Electric Station

When the low red brick building, without stack or evidence of any boiler room, is pointed out as the electric generating plant, one is inclined to doubt his informer.

The steam generating plant has been placed at approximately its center of distribution, and the electric generating station has been likewise located relative to its load, so that as a result, these 2 buildings are found to be nearly ½ mile apart.

As may be expected around any oil refinery, the air is unavoidably thick with heavy black smoke, and all objects are covered with inevitable oil-soaked soot. It is, therefore, a pleasure to enter the engine room with its immaculately clean floors, walls and ceilings, its highly polished engines and its clear air.

Current used for light and power purposes around the grounds and in the various manufacturing departments is generated by 3 direct-connected units, each consisting of a General Electric alternating-current generator, rated at 400 kv.a., 480 v., 3-phase and running at 100 r.p.m., driven by a simple, noncondensing, 32 by 48-in. Filer & Stowell-Corliss engine, and excited by a belted exciter rated at 22 kw., 125 v., and running at 500 r.p.m.

At the extreme end of the building is located the black slate switchboard built up of 3 generator and 4 feeder panels, each equipped with the necessary ammeters, wattmeters, manually operated oil switches, field switches, field rheostats, and at the end of the board serving all generator panels is a swinging voltmeter and a swinging synchroscope.

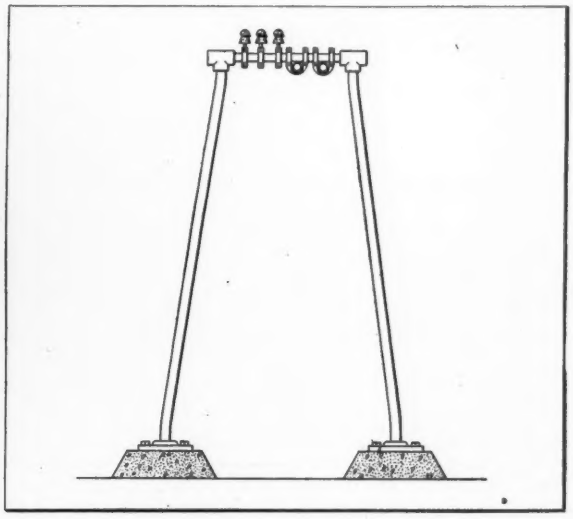


FIG. 4. TYPE OF SUPPORT USED FOR ELECTRICAL, AIR AND WATER TRANSMISSION LINES

Next to the switchboard is a 2-kw., 125-v. motor generator set used to charge the storage batteries of the private telephone and fire alarm systems maintained on the oil company's premises.

Air Supply

Due to the hundreds of steel tanks, stills and pipe lines used in the refining industry, it is necessary to employ a large crew of boiler makers and pipe fitters to carry on not only new construction work, but also for repair jobs. To operate the pneumatic drills, riveters, etc., 2 2-stage steam driven air compressors are in operation in the same building, housing the electrical generating sets. The larger and newer of these 2 compressors is an Ingersoll-Rand having steam cylinders of 23 by 30 in., and air cylinders of 32 by 30 in. and 19 by 30 in., while the other is of an early type, built by the Ingersoll-Sargent Drill Co., of New York.

Transmission Systems

Supports built up of iron piping, as shown in Fig. 4, are used to carry the electrical distribution lines, the water line for fire protection and some of the overhead air lines.

Due to the great and ever-present fire hazard, it is necessary to take special precautions against this danger,

and in addition to the stations containing the regular fire fighting equipment, pipe lines are carried to and into the various stills and tanks. These lines are led into the tops of the tanks and should a fire develop in any of them, due to carelessness on the part of any workman or due to the tank being struck by lightning, as frequently occurs, thus igniting its contents, the fire can at once be checked by flooding the tank with water.

Air leaving the receiver is conducted to the various points of the grounds by a so-called loop system of piping, this system being employed so as to insure a continuous supply of air, even though a part of the transmission line should become inoperative due to a breakdown or alteration. Nothing, therefore, short of a break between the receiver and the first branch of the loop can shut down the system or interfere with its working.

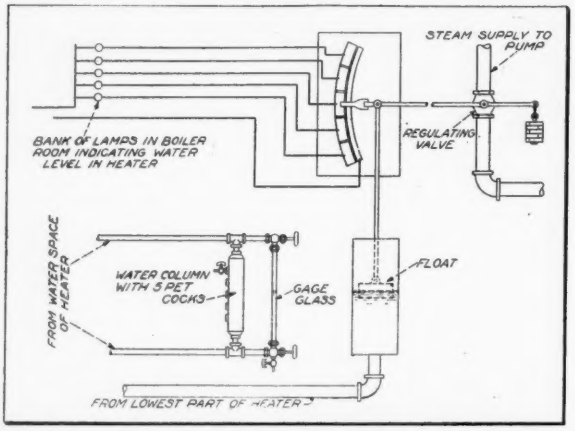

STEAM SUPPLY TO PUMP
REGULATING VALVE
BANK OF LAMPS IN BOILER ROOM INDICATING WATER LEVEL IN HEATER
FROM WATER SPACE OF HEATER
WATER COLUMN WITH 3 PET COCKS
GAGE GLASS
FLOAT
FROM LOWEST PART OF HEATER

FIG. 5. GENERAL ARRANGEMENT OF GAGE GLASS AND FLOAT LOCATED IN BOILER HOUSE AND CONNECTED TO HEATER OUTSIDE; LAMPS IN BOILER ROOM INDICATING WATER LEVEL IN HEATER

All joints of the air line are regularly inspected for leaks by going over them with a coat of black paint, and should any leak be present, it will manifest itself by creating a bubble.

All low points of the system are provided with try cocks by means of which any accumulated water may be removed.

Expansion and contraction of the air lines is cared for by offsets in the piping and in some instances by means of slip joints.

Petting the Boiler

By Stanwood George

"SAY, Jake, how's the old boiler down at No. 3 plant doing these days?"

"Shut down."

"Shut down? Well, what on earth's the matter with her? She's been on the job all right and hasn't shut down all winter."

"Guess that's so," said Jake. "From the looks when we got inside, I thought that she hadn't been stopped for a year."

This, by way of extract from the morning confab of the Super with Jake, newly arrived, and in charge of the steam plants in a steel plant in a section where the water was none too good. Three years' reading of Practical Engineer had taught him where to look for trouble, and in trying to cut down the tremendous coal bill, he naturally turned first to the boilers to see whether heat units got astray right at the start of the power making process.

Then the Super: "What in thunder did you go inside for, anyhow? Now, I suppose you'll have to keep her out of commission for a big repair bill."

"Well, see here," said Jake, "I'll tell you what and why and all about it. Then, if you say so, we'll run the rest of the boilers the old way—not. Leastwise, I won't. Mebbe somebody will for you, but I don't think for long.

"You know that old boiler was laid up with 3 tubes burned off on the lower row when I came and you wanted her fixed quick. The boiler makers came, and when they got those tubes out, they said, 'Call in the steam shovel and dredge out these rocks,' and we got busy and dug out a barrel and a half of scale. Those 2 boiler makers and I worked 2 hr. getting the scale out of the blowoff pipe, which is 4-in. from the boiler, but some crazy Indian had reduced it to 2 in., just below the boiler, and then to 1½ in. at the valve. We fixed that for you, and then I put in a good gallon of kerosene oil and about 2 lb. of washing soda.

"We filled her up and then fired slowly, and ran her as you know, 4 weeks, and I thought that she ought to be washed out. We'd looked her over every day on the outside and she seemed to be all right, but all that scale worried me.

"So we let her cool down, and I opened the combustion chamber at the back end and went in with an electric extension cord, on a visit. I went at the back end of the flues and saw a red streak down from one of the new flues, and they'd been in only 4 weeks, mind you. 'What the Dickens does that mean?' thinks I, but there was nothing wrong on the end of the tube, so I put a candle at one end and squinted through from the other, and down in the middle was a leak.

"Next morning we got the boiler repair gang and put in another tube and dredged scale some more. That split had started 5 in. in length and was right ready to go some more and do real business. We got in a new tube and raised steam in 2.5 hr., but we've shut her down now for a good overhauling, and I want to do the same by each of the boilers in turn, both old and new.

"So far as I can find, the man who was on this job hadn't washed any boilers for 6 months. I guess that's right. I thought I had seen dirty boilers, but that one was the buggiest ever.

"We've got to plan to wash those boilers each month, even if we get a new boiler in each plant, unless you want all the boilers to get old and shaky before their time. We'll have to fix up the old one at No. 3 plant anyhow, but I find that boilers and pumps are like humans, they like to be petted; and the more you do for them, the more they will do for you. I've got the scale out of all of 'em, water glasses clear as crystal, and I want to keep it out.

"What do you say, Super? Shall we plan a regular bath and inspection routine, or do I hunt the gravel?"

"Oh, well! Fix it up."

Air Compressors as Vacuum Pumps

EFFECTS OF CLEARANCE; REQUIREMENTS OF COMPRESSOR; PERFORMANCE CURVES. BY FRANK RICHARDS

THERE are now in established employment in various lines of manufacture automatic and other machines which require a considerable vacuum for their operation. There is also extensive use of high vacuums in distillation and evaporation processes, such as occur in the manufacture of sugar, glucose, malt extracts, glue, etc., so that there is an established and permanent demand for machines of large capacity for the removal of air at pressures far below the normal atmospheric.

Vacuum pumps have generally been regarded as more or less special machines, and also they have usually been of capacities much below the modern demands here spoken of. The operation of producing vacuum by mechanical means is strictly an act of air compression, and it should be legitimate employment for the standard air compressor.

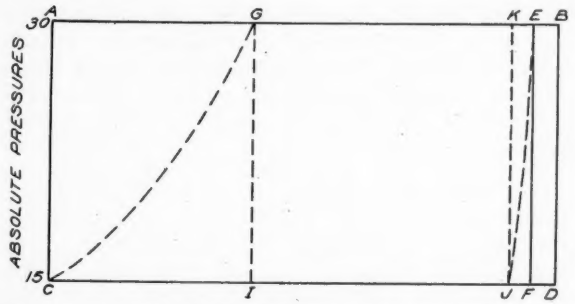


FIG. 1. DIAGRAM SHOWING EFFECT OF CLEARANCE WHEN COMPRESSING FROM ATMOSPHERIC PRESSURE

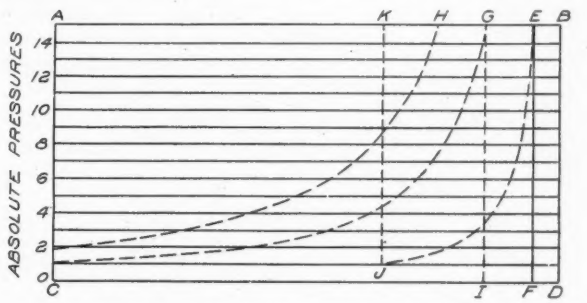


FIG. 2. EFFECTS OF CLEARANCE WHEN COMPRESSING FROM BELOW ATMOSPHERIC PRESSURE

Until we come to a perfect vacuum, which is not at all contemplated in the present article, the actual so-called vacuum with which we are more familiar is simply air at a reduced or attenuated pressure, we have only to remove some more of this low pressure air and to expel and deliver it at the actual pressure of the surrounding atmosphere.

In practice, however, if we take an ordinary air compressor for this work we soon find that there are some details of construction and operation which are imperative for such service, but which are quite negligible for normal atmospheric intake and high pressure delivery.

In the mechanical compression of air,—whether the air have a pressure measured by a column of mercury 30 in. high, ordinary sea level atmospheric pressure, or by only 1 in. of mercury, which latter may be said to be near the limit of practical mechanical air pumping in large volume and at a speed not unprofitable,—in either case the cylinder can only be filled by some surplus of pressure outside the cylinder to force the air in to follow the piston, so that it is absolutely impossible to produce a perfect vacuum in this way.

It is evident that if the air while being driven in by the air behind it to fill the cylinder, has also in the act of entering the cylinder some work to do, such as overcoming the inertia of a poppet valve to open it, and the opposition of the spring which normally holds the valve in the closed position, this also must interfere considerably with any possible approach to a perfect vacuum. If instead of poppet valves, to be opened by the pressure of the entering air, there is a mechanically moved inlet valve which is opened at the beginning of the intake and held wide open for practically the whole stroke, this must materially reduce the requirement of pressure excess outside the compressor and make a more attenuated vacuum possible. It is a fortunate thing that there is a type of compressor equipped with intake valves —Corliss valves—which satisfy the conditions above indicated, and it is a natural consequence that these compressors—as will appear later—give highly satisfactory results in vacuum pumping.

The second essential condition required for successful vacuum pumping by an air compressor is that cylinder clearance shall be as small as possible. In operation it is necessary, not only that the air shall be taken into the cylinder for compression, but also that as much of it as possible shall be expelled after the compression. Some clearance seems to be absolutely unavoidable, but the air remaining in the clearance space re-expands upon the return stroke, and the new air taken in for the next stroke is only the difference between the volume occupied by this re-expanded air and the volume which would constitute a whole cylinderful.

The different effect of cylinder clearance when taking in atmospheric air or when pumping from a high vacuum should be clearly understood by comparing Figs. 1 and 2. In Fig. 1 the area ABDC represents the entire volume of an air cylinder, including the clearance EBDF, this clearance being 5 per cent of the entire volume. The compression is assumed to be from atmospheric pressure, 15 lb. per sq. in., absolute, to a pressure of 2 atmospheres, 30 lb. absolute, or 15 lb. gage. GC is the adiabatic compression line, GBDI will be the volume after compression, and GEFI will be the volume delivered leaving the volume EBDF in the clearance space. Upon the return of the piston, EJ will be the re-expansion line and the volume of fresh air to be taken in for the next stroke will be AKJC, or more than 90 per cent—it is not necessary to figure minutely—of the full capacity.

In Fig. 2, the cylinder volume and the clearance are the same as before; but the compression on line G is from an absolute pressure of 1 lb. to atmospheric pressure, or 15 lb. absolute. Here EJ will be the line of adiabatic re-expansion for the air in the clearance space, and the area AKJC, 65 per cent of the whole volume, which can possibly be got into the cylinder for the next stroke. In practice, the actual showing would not be as good as this in consequence of the inertia and friction of the air; but the effect of the clearance is sufficiently suggested.

It should scarcely be necessary to call attention to the importance of having tight valves, both inlet and discharge, in a compressor for this service. Also it is to be noted that when working to a high vacuum the ratio of compression is very high, approaching an infinite value as the vacuum produced comes near to the local barometer reading, which large ratio results in high temperatures, and in order to attain a reasonable compression efficiency, as well as to secure proper lubrication, the cylinder of an air compressor for vacuum pumping should be thoroughly water jacketed.

Following this setting forth of the compressor requirements for high vacuum pumping, I take pleasure in presenting an interesting series of indicator cards from a compressor in actual commercial service, which cards mostly tell their own story.

The compressor from which these cards were taken is in constant service at the plant of the Diamond Alkali Co., Fair Port Harbor, Ohio. It is an Imperial, Type 10, compressor of the Ingersoll-Rand Co., of standard duplex construction except that the vacuum cylinders are of abnormally large diameter, 27 in., and the steam cylinders 14 in., with a common stroke of 20 in. It is used exclusively for vacuum pumping and from actual test is capable of maintaining, when exhausting a large receiver, a vacuum within 0.9 in. of barometer. If the intake had been blanked off short at the compressor, the vacuum produced would have exceeded this, as minute, undiscoverable leaks are almost unavoidable. This very complete series of cards is valuable as showing the working under difference conditions, and especially the influence of the clearance when high vacuums are reached. The curve sheets 1, 2 and 3 of Practical Reference Tables give a comprehensive idea of the general performance of the compressor at all possible intake and discharge conditions.

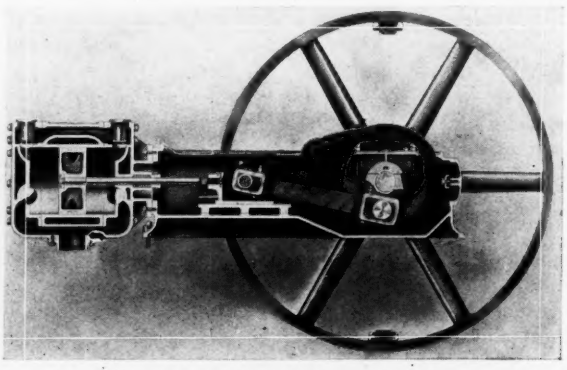


FIG. 4. TYPE OF COMPRESSOR USED BY THATCHER MFG. CO.

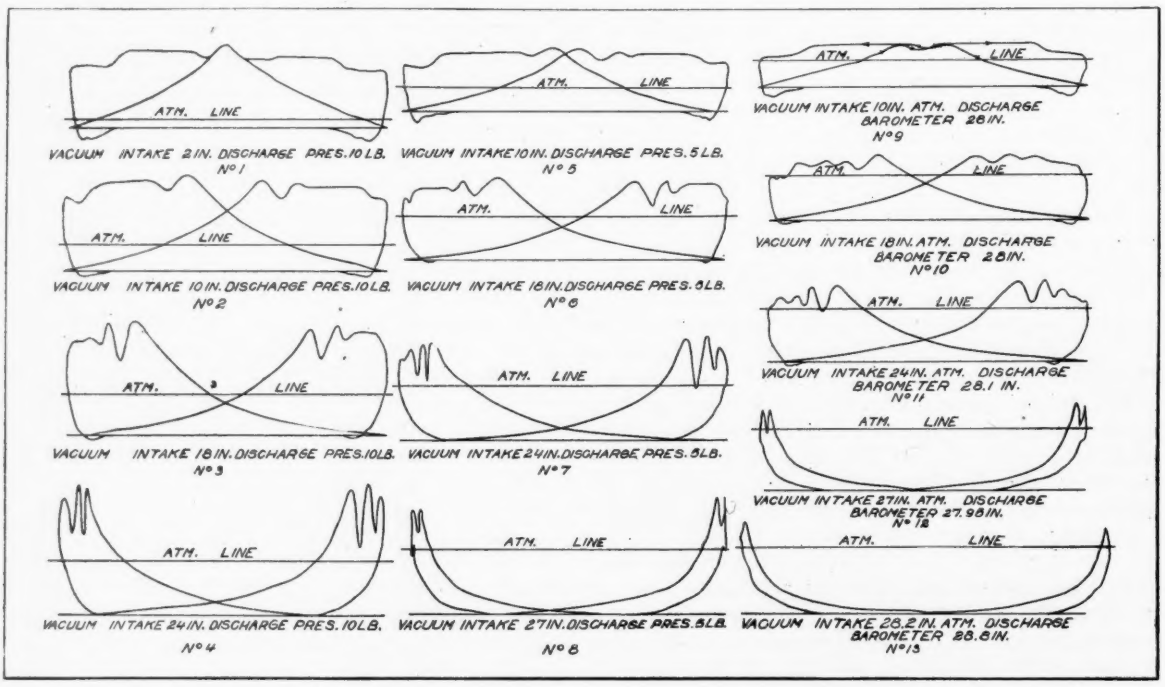

ATM. LINE
VACUUM INTAKE 2 IN. DISCHARGE PRES. 10 LB. N° 1
ATM. LINE
VACUUM INTAKE 10 IN. DISCHARGE PRES. 5 LB. N° 5
ATM. LINE
VACUUM INTAKE 10 IN. ATM. DISCHARGE BAROMETER 28 IN. N° 9
ATM. LINE
VACUUM INTAKE 10 IN. DISCHARGE PRES. 10 LB. N° 2
ATM. LINE
VACUUM INTAKE 16 IN. DISCHARGE PRES. 5 LB. N° 6
ATM. LINE
VACUUM INTAKE 18 IN. ATM. DISCHARGE BAROMETER 28 IN. N° 10
ATM. LINE
VACUUM INTAKE 18 IN. DISCHARGE PRES. 10 LB. N° 3
ATM. LINE
VACUUM INTAKE 24 IN. DISCHARGE PRES. 5 LB. N° 7
ATM. LINE
VACUUM INTAKE 24 IN. ATM. DISCHARGE BAROMETER 28.1 IN. N° 11
ATM. LINE
VACUUM INTAKE 24 IN. DISCHARGE PRES. 10 LB. N° 4
ATM. LINE
VACUUM INTAKE 27 IN. DISCHARGE PRES. 5 LB. N° 8
ATM. LINE
VACUUM INTAKE 27 IN. ATM. DISCHARGE BAROMETER 27.98 IN. N° 12
ATM. LINE
VACUUM INTAKE 28.2 IN. ATM. DISCHARGE BAROMETER 28.8 IN. N° 13

FIG. 3. SERIES OF INDICATOR CARDS FROM AN AIR COMPRESSOR USED AS VACUUM PUMP

A still more interesting installation is that at the plant of the Thatcher Manufacturing Co., Elmira, N. Y. This is an Imperial, Type 10, short belt drive compressor, having duplex air cylinders 18 in. diameter, 14 in. stroke, operating at 185 r.p.m. One cylinder takes in

free air and delivers it to a receiver at about 20 lb. gage; the other cylinder is used as a vacuum pump, exhausting a receiver to about 19 in. vacuum and discharging to the atmosphere. This combination of compressor and vacuum pump has numerous advantages over the customary dual machine installation in cases where an air pressure as well as a vacuum is wanted. This combination compressor and vacuum pump is used for operating 3 Owens Bottle Making Machines, the vacuum produced being used to draw the glass into the molds, the pressure then blowing the bottles.

The performance of the vacuum cylinder of this machine is clearly shown on curve sheet No. 4 of the Practical Reference Tables. Actual cards were taken from this machine when the vacuum produced was less than one inch of barometer. This machine at the time was exhausting a large receiver, and a closed inlet would have shown a still greater degree of vacuum to have been produced.

For all the material embodied in this article, and more which space forbade, I am indebted to A. W. Deyo, Painted Post, N. Y.

Boiler Inspection

COMPLETE DIRECTIONS FOR INSPECTING A WATER-TUBE BOILER. BY J. C. HAWKINS

THERE are many boiler plants even in localities having strict boiler inspection laws, as well as in other localities having no inspection laws at all, in which the duty of examining the boilers at regular intervals is left entirely in the hands of the state or insurance inspector. The engineer in many cases considers that after the inspector has gone over the boilers and examined them, no other inspection is necessary. This is probably true as far as safety is concerned, although a frequent examination by those in close touch may discover faults or gradual deterioration that would not be apparent to a stranger.

It is not within the province of the inspector to determine whether the boiler is in the proper condition to produce economical results. The engineer or chief engineer, if there is one, should make it a point to don a suit of overalls when the inspector arrives, and go over the work with him, discussing any points that may come up. This will not only help the specialist to examine your boilers, but will be of advantage to both. Make him a confidant as to any changes that have been made, or that are contemplated, and whether you act on his advice or not, it will do no harm to know what he thinks of the proposition.

There are so many things that the engineer should watch for that are of only passing interest to the safety inspector, that the chief engineer, boiler superintendent, if there is one, or some experienced employe who is responsible for the operation of the boilers, should give them a thorough examination both internally and externally at stated periods, not only for safety, but for economical operation, and to keep a close record of their action as well as in anticipation of future needed repairs.

As a rule, boilers of the water-tube type will require more frequent inspection than some other types because they are more complicated in construction; they are operated at a very high rate, and at times are forced greatly in excess of their rated capacity; the setting is cut up with many openings, and the chance of air leakage through the setting is very great.

It has been the writer's practice wherever possible to do so, aside from going with the insurance inspector when he makes his annual inspection, to give the boilers a thorough inspection at stated periods, the length of which depends on the circumstance of operation. It has been the means of discovering many of the defects which are bound to arise, which although not directly affecting the safety of the boiler, did affect the economy, and which without this inspection probably would not have been found until they became quite serious, and it gave us a chance to be prepared beforehand to make needed repairs without delay.

In one plant having 6 water-tube boilers usually fully loaded, and using a very bad river water, the boilers were washed every 2 weeks, but were taken off the line to be thoroughly cleaned and repaired, if repairs were necessary, every 3 months. At these times the boilers were thoroughly examined. Another plant of 4 boilers, having less trouble with scale, was examined in the same manner. This was done about as follows:

The fires are drawn, and the main steam valve closed and locked with a padlock and chain to prevent anyone from opening the valve by mistake while the boiler is being worked on. The feed water is left turned on a little until all steam is worked off and the blowoff is left open a little to keep the water from getting too high, and also to keep the high water whistle from blowing. The boiler then stands a day or two full of water with all doors closed, which allows it to cool down slowly, and prevents the scale from baking onto the shell and tubes. Then the grates and combustion chamber are cleaned, also the tubes and all external surfaces of the boiler; this is done by washing down with a hose. Next the drums are opened, and the scale scraped off. Sometimes it can be scraped off easily, but it may have to be chipped off with the scaling hammer. After the drums are cleaned the turbine cleaner is run through the tubes. In one plant, for certain reasons boiler compound was not used, but was used in the other plant although the cleaning is done in the same manner. After the cleaning, come any repairs that are found to be required, such as new tubes, repairs to grates or stokers, new furnace walls, etc., then the inspection.

EQUIPMENT REQUIRED

WHEN THE engineer makes a practice of inspecting the boilers at frequent intervals, it is advisable to have a one-piece suit made especially for this purpose similar to that usually worn by the regular inspector. A few tools are needed, such as an electric light with guard, on a long extension cord, a small cross-peen hammer made extra long with the peen quite sharp so that

the scale or burned ashes may be chipped off. The inspector should also have a notebook and pencil, and if it is the first examination that the boiler has been given by the engineer, a scale and pair of calipers should be taken along so that the dimensions of all the parts may be taken, which are entered on the report for future reference, but need not be taken after the first inspection unless there is some good reason for it.

Outline of Procedure

After putting on the inspection suit, go in on the grates with the tools. First, look at the tubes. Note whether there are any bags or blisters; if there are any, note whether they are worse than at the last examination. Notice whether there is any evidence of leakage around the ends of the tubes or staybolts, and if any is found make a note of it in the book.

Examine the furnace side and bridge walls. If any repairs are needed, jot it down. Then the front baffle wall,—note if it is in good repair. A leak at this point will affect the economy of the boiler as it bypasses a part of the heating surface. Sometimes the space between the tubes on the back side away from the soot blowing holes will be found plugged up with ashes. Look for this by holding the light above the head so that it will shine between the rows of tubes. Examine the grates and stoker if there is one, noting the condition of the bars and air spaces, take a last look around and come out.

Next, go in above the tubes under the drum, look for bags on the bottom of the drum, also leaking rivets. Tap them and the tubes with the hammer, hold the light so that it will shine between the tubes, and examine the baffle walls, also the brick work around the drum and the top of the tubes. Leakage through here will also reduce the economy of the boiler, as it bypasses part of the heating surface. Make notes of whatever is seen.

The next place is the combustion chamber. In here examine the tubes for bags, which seldom occur at this point. Examine the rear staybolts, tube ends and brick work for leakage. Make a note of any tubes or staybolts that are found leaking. Examine the blowoff pipe for leakage, rapping it hard with the hammer, noting whether it seems solid and in good condition. Particular attention should be paid to the blowoff pipe as it is liable to become externally corroded by the action of the acids in the soot, especially at the edge of the brick work, and in the pipe threads. It may be possible that, as the boiler or pipe becomes heated in firing up, it will expand in such a manner that a severe strain will be put upon it. This should be looked for, as it may cause the pipe to be broken off.

Next examine the nipples between the rear header and mud drum, if there is one. Clean away the scale and ashes, and look for external corrosion or leakage, which is liable to be found at this point. Examine the rear baffles, which are usually found all right, and come out. Go in above the tubes at the rear end, see whether the tubes are properly cleaned, look at the tube ends and staybolt heads for signs of leakage, examine the baffle walls, and examine the action of the damper while the helper opens and closes it, to see whether it opens or closes tight when the lever on the outside indicates that position. Sometimes the gear may slip, and the damper will be only partly open when the lever indicates that it is wide open.

Next come the outside walls. Look for cracks in the setting, especially around the doors on the side; also, see that the doors shut tight. Air leaks in the outside walls and doors may be found while the boiler is in operation by closing the damper nearly tight, and throwing in a shovelful of fine coal. The smoke will pour out through all the cracks and crevices through which air may be drawn in with the damper open. These places should be marked, and the repairs made, and examined at this time. Next, go over the tops of the boilers, and examine the setting for cracks, leaky pipe joints and flanges, leaky valve stuffing boxes, etc. The safety valve and blowoff valves should be watched for leakage while the boiler is in operation. If the safety valve has been leaking, now is the time to regrind or repair it.

A leaking blowoff valve may be found by disconnecting a flange between the valve and blowoff tank while the boiler is under pressure, and if required, it should be inspected to see that the repairs were properly made. Next examine the water column floats, piping, feed water regulator, feed valves and piping, check valves, gage cocks, water column blowoff pipe and valves. See that they are free from scale, and in good working order. Examine the valve seats to see if they are cut unless they have been repaired. This finishes the external surfaces of the boiler. When several boilers are to be examined it is best to go over all of them externally, making notes on each boiler separately before going inside.

To make the internal inspection, go inside the drum first, and look for signs of pitting, especially along the water line, also look for scale and corrosion in all parts of the drum. Knock off some of the scale to see how thick it is, and what its composition is. Also measure the depth of any corroded pitted spots, making a rough sketch of them and their location, with such other data as will be essential in making a clear report of the trouble, and which may be used at the next examination to determine whether the trouble is getting worse or not. Tap the braces with the hammer to see if all are tight, and examine the mud pan and internal feed pipe to see whether they are clear. Sometimes the internal feed pipe will be found nearly stopped up with scale, or may be loose in the boiler head. See that the dry-pipe is in proper position, and that the holes are clear. Sometimes this pipe turns so that the steam holes are on the bottom side instead of on top as they should be, which condition of course defeats the purpose of this pipe.

Examine the connections to water column and steam gage. Take plenty of time in here, as it is very important, and nothing should be overlooked. Next come the staybolts and tubes in the water leg or header. Have a helper hold a light at the front end of each tube, or if all the caps are not taken off, take off a few on each end at random and look through the tubes to see whether there is any scale, and what the general condition is. Sometimes a bunch of loose scale will be found in a tube that has just been cleaned with the turbine cleaner, which might lodge there and be the cause of a bagged tube. Reach through the handholes with the hammer

and tap each staybolt to find whether it is solid and tight. Examine the tube cap joints, noting whether they are in good condition, with no old gaskets sticking to them.

Improvements Suggested by Inspection

This covers the boiler inside and out, and includes parts that the insurance inspector would not look at very closely as it does not affect the safety of the boiler. If the tubes are found dirty, either inside or outside, some better method of cleaning them to prevent them from getting in this condition may suggest itself to the engineer while making this inspection. Likewise, cracks in the setting may suggest some remedy whereby the percentage of CO_2 may be increased, and any needed repairs that have been overlooked may be found and made before the boiler is put in operation. After the inspection is completed, the steam gages should be taken down and calibrated, and all adjusted to read properly. If a gage tester is not to be had, they may be connected to a pressure line on which there is a gage that is known to be correct, or one that is kept for testing purposes. It is very important that all gages on the boilers be nearly correct, because it is dangerous to cut in a boiler when its pressure is not equal to the line pressure. A correct steam gage is also a check on the safety valve. If the safety valve has been repaired or reground, it will have to be set, especially if of the pop type, after the boiler is fired up. This should be done by a responsible man, and an accurate gage must be used to set it by.

After the inspection is completed and the inspector has gotten cleaned up, some sort of a report should be made of the conditions found while it is fresh in the mind. The value of this report as a reference will depend entirely on how nearly complete it is made. Some of the things to be looked for in the inspection need not be mentioned, but they should not be overlooked in the inspection. This report should make it possible to compare the conditions of the boiler at the present time with its condition at former examinations. It should also make a note of any repairs that are likely to be needed at the next shutdown, that the material may be ordered ahead so that it will be on hand when wanted, to prevent unnecessary delay.

On the first inspection all the dimensions of the boiler and setting should be taken for future reference. This need not be done on subsequent inspections unless there is some good reason for it. These dimensions are placed on each report sheet for reference.

The inspection described here applies principally to the horizontal type of water-tube boiler; but the same procedure, as far as it can be applied, may be used on any boiler. The water-tube boiler is more easily inspected than an internally fired boiler, especially if the latter is of small size, in which case it is almost impossible to give it more than a superficial examination.

There are many more joints and parts in the water-tube type, and the boilers are frequently of such great capacity that a proper inspection of all parts is no small job, and it is more important that it be made than in boilers of other types.

An inspection of this kind every 3 or 4 months will keep the engineer in charge of the boilers thoroughly familiar with the existing conditions of each and every part of the boiler. It is a dirty job, but will make the engineer's work easier in the end, help to keep the efficiency of the plant at the highest point, and prepare him to meet emergency breakdowns by anticipating them beforehand, and having the necessary spare parts on hand, or making the repair before it becomes serious. The records should be made of uniform size so that they may be filed away. No set form that would be suitable for all plants can be stated, but each engineer will be able to design the kind of record that seems to apply best to his conditions, and if it is complete it will give a complete record of the boiler in detail, especially if the repairs made between inspections are noted on it, also the cost thereof.

New Humidity Regulated Dry Kiln

Construction; Control; Advantages. By H. D. Tiemann

A KILN recently designed by the Forest Service fulfills the 3 fundamental requirements for good drying; namely, control of humidity at all times, ample circulation, and proper temperature.

Briefly, it consists of a main drying chamber as in an ordinary kiln, but having a partition on either side, making 2 narrow side chambers open top and bottom. The accompanying diagram shows a general cross section of this kiln, in which A is the main drying chamber, E, E, the partitions and B, B, the narrow side chambers. The sides of the chambers B, B, are lined with suitable waterproofing, and near the top are sprays of water, while at the bottom are gutters, G, for collecting the water from the sprays, and baffle plates, D, for eliminating all residual spray or mist from the air, leaving the air in a pure saturated condition as it enters the space, C, beneath the steam coils, S.

The sprays induce an increased circulation of air in the kiln and control the humidity, the latter being accomplished by regulating the temperature of the spray water. The principle is simple and may be called the dew-point method, since the air, as it enters the space C beneath the heating coils, is saturated and its temperature is, therefore, the dew point of the air after it passes up through the coils and is heated to whatever temperature is required in the drying room. Given the temperature of the drying room and of the dew point, the relative humidity† is thus determined. By controlling the temperature of the dew point by means of the temperature of the spray water, the relative humidity is positively regulated at any desired temperature of the drying room. It will be noted that the action of this kiln is independent of outside atmospheric conditions, and the tighter the kiln is closed the better.

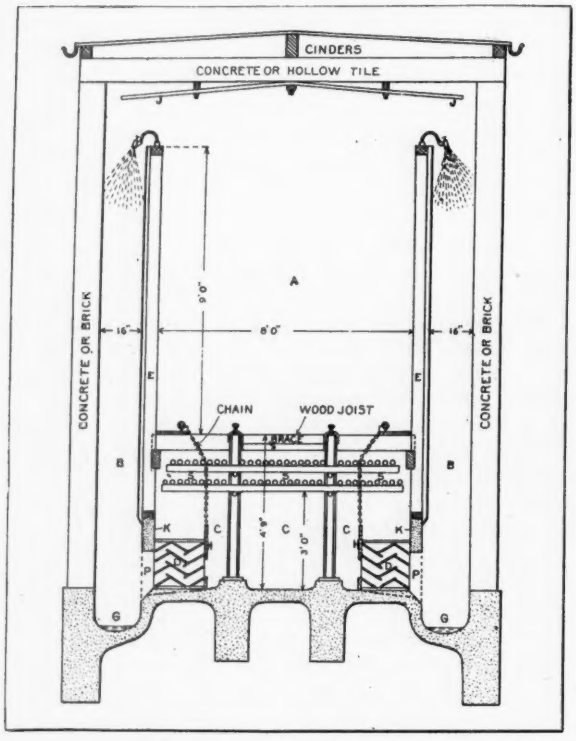
For controlling the temperature of the drying chamber a thermostat is placed on the steam main. It is desirable when possible to use high-pressure steam reduced to the desired pressure by means of a reducing valve, as this allows of a wide range of temperatures.

As a matter of practical operation, the kiln accomplishes the results explained in the discussion of the

†The relative humidity is simply the ratio of the vapor pressure at the dew point to the vapor pressure of saturated vapor at the actual temperature of the chamber.

theory given above. The actual measured circulation of air at temperatures in the drying chamber of 130 to 160 deg. F. varies between 70 and 200 cu. ft. of air per minute per foot length of kiln.

While the physical conditions for drying are satisfactorily obtained by this kiln, the question of the mechanical heat efficiency has not been fully worked out, and experiments are being conducted with this end in view. It is evident that excessive circulation while in nowise detrimental to the drying process or to the control of the humidity, nevertheless causes a loss in mechanical efficiency due to simply heating and cooling air as it recirculates. This loss is greatest at the low humidities and disappears at high humidities. It is believed that it can be greatly reduced by using a stream



FOREST SERVICE HUMIDITY CONTROLLED DRY KILN—SECTIONAL VIEW

of water in place of the sprays at the latter part of the drying operation, which would, in fact, be an approximate control of humidity by not cooling the entire volume of recirculating air to the dew point but only that portion of it which comes in contact with the stream of water. Experiments with this end in view are in progress. For high humidities which are necessary during the first ½ or ⅔ of the operation in drying green woods, this kiln with the spray is much more efficient mechanically than an ordinary ventilated or blower kiln operated at the same humidities. All the heat except that lost through radiation through walls, doors, etc., including the heat required to vaporize the moisture in the wood, reappears in the temperature of the water derived from the sprays which is recirculated by a pump and used repeatedly.

For the past 2 winters, the Forest Service has been carrying on experiments in a wooden kiln of this kind 14 ft. wide by 36 ft. in length at Berkeley, Cal., in drying eucalyptus. A small brick kiln is now in operation at this laboratory, in which large oak, hickory, birch, and maple wagon stock has been successfully dried, some from the green condition and some from partly air dried. It is found that material which is badly surface checked due to air drying (particularly oak) will sometimes come out of the kiln with the checks entirely closed, so as to be invisible. Of course, the weakness still remains, as the checks do not actually seal.

With the high humidities necessary for successfully drying green wood, condensation occurs on all surfaces which are slightly cooler than the air in the kiln (below its dew point), a thing apt to happen on the roof and drop down upon the lumber. The trouble may be overcome by suspending a false ceiling below the roof proper, J, J, in the figure, or by heating the roof by means of a steam coil.

It should be noted that the air in a dry kiln may feel moist to the hand or face when in reality the relative humidity is exceedingly low, too low for proper drying. The reason of this is that the temperature of the body is below the dew point of the air in the kiln. As long as the dew point is above 98 or 99 deg. F. the air will feel moist to the skin. Thus, at 130 deg. F., 40 per cent relative humidity will feel moist and at 180 deg. F., 12 per cent will feel moist; 60 per cent humidity at 140 deg. F. will extinguish a lantern and is greater than a person can endure for any length of time. Yet, for the first part of the drying of green lumber, humidities ranging from 95 to 70 per cent must be carried. Humidities as high as this at temperatures above 130 deg. give the appearance of dense clouds of condensed steam as soon as a door is opened, or any of the air comes in contact with the outside atmosphere; yet within the kiln the air is absolutely clear. This sometimes deceives people into thinking that steam is escaping, which is not the case.

Advantages of being able to control the humidity at these high values, as against letting free steam escape into the air, must be evident. A slight variation in humidity means a change in the rate of drying, and with free steam escaping into the air there is no means of knowing what humidities are being produced. In some places the air may be saturated and in others too dry; or at one time the air may be moister than another. Thus, the lumber may be gaining in weight in places and drying too fast in others, or it may dry too fast one day and gain in weight the next. The humidity control does away with this difficulty and the rate of drying is not only rendered uniform but can be accurately controlled at all times.

ANNOUNCEMENT IS MADE by Alexander Dow, president of the Edison Illuminating Co., of Detroit, that work will begin at once on a new $125,000 substation on the south side of Congress St., between Cass Ave. and Wayne St. The building will cost about $40,000, and the equipment $85,000. About 5000 kw. will be generated from the first, but eventually it will be increased to a 10,000-kw. station.

Boiler Repairs

HARD PATCH. BY J. HOWARD COATES

A HARD patch differs from the soft patch only in application. No gasket is used, the edges being beveled and calked instead and rivets in place of cap bolts or bolts and nuts are used for securing the patch to the defective plate.

Many authorities on the steam boiler advise that when patches are required it is time to install a new boiler; but upon second thought, it will readily be seen that such advice would not work in all cases, as new boilers have been burned and patched before seeing a year of service.

A patch properly applied and completed in a workman-like manner is in no way detrimental to a boiler except insofar as the allowable boiler pressure is decreased. Of all boiler troubles as regards repair, the patch is the last resort and in consequence must be well fitted and secured, the size and shape of the patch depending in all circumstances upon the plate to be patched.

Boilers of the horizontal tubular, locomotive and marine type are most susceptible to defects which require patching, by which I do not mean that other types are exempt, but due to their design, defects for which a patch is the antidote develop more often.

A horizontal tubular boiler may bag so badly that it is impossible to drive it back. Boilers of the locomotive and marine types have bulged fire and crown sheets and cracks develop between staybolts; when serious, a patch is the result and must be what is termed a "hard patch."

A boiler of the horizontal tubular type developed several fire cracks at the first girth seam; leakage, with its attendant result of corrosion, became so rapid that the owner and his engineers suggested a belt patch. To all outward appearances this was feasible, proper and not expensive.

The boiler inspector advised against the patch, saying that its position would become a point of unusual stress, that 2 rows of rivets would be necessarily exposed to the fire and that the unequal expansion, together with the weakened joint, would always give trouble. He advised that 4 in. of defective shell be cut off all around. The boiler was shortened up for that amount and shell reriveted, necessitating cutting off 4 in. from all tubes and their re-rolling and beading, but when completed, the boiler was as new.

The foregoing has no bearing upon the subject except to illustrate the undesirability of a patch, unless an absolute necessity, and a diplomatic method of obviating the necessity.

One of the hardest places to patch is a corner of the firebox in a locomotive type boiler for, due to the different expansive movements of the fire and tube sheets, the operation becomes one of serious study and in many cases assumes such a proportion that a whole new sheet or even a complete new fire-box is the result.

The application of a hard patch involves the same operation in all cases, although various positions and conditions require different calculations, which in furnaces of the locomotive type apply to staybolts, tube ends, sheet seams and the always present varied expansions.

For purposes of illustration, assume that a crown sheet of a locomotive type boiler becomes defective near its center in such proportion that a patch is necessary and not sufficiently serious to warrant a new sheet, the staying of the sheet being what is known as radial. Staybolts 1 in. diameter and pitched 7 by 5 in. The defective plate to be cut out is 5/16 in. thick and consists of a diagonal crack between staybolts. The patch to be of the same thickness and must be placed on the inside to prevent a pocket.

The spacing of the staybolts must be taken into consideration, which, in this case, would necessitate the cutting out plate to a dimension of 11¾ by 7¾ in. Assuming that a ¾-in. rivet is to be used, which is ample, the patch plate should have a lap of 3 times this diameter, which would make the patch 16¼ by 12¼ in., with a rivet way of 14 by 10 in. This involves the necessity of cutting out the 4 staybolts inscribed; after patch is riveted up, the stays are renewed but are next size larger in diameter, or 1⅛ in. A calking of the patch from the furnace side with a round nosed tool under a light water pressure complete the repair.

Since the advent of the electric furnace or torch and oxy acetylene burners, several methods of boiler repairs are undergoing radical changes. The high temperatures thus obtained and confined or localized to a point permit of welding in difficult places the operation in the hands of a capable man under good working conditions is rapid, cheap and efficient, and is permissible on all repairs subjected to compressive pressures and upon repairs subject to bursting pressure under given conditions but not in all cases. It is obvious that in a great many instances cracks, corrosion and defects of a similar nature will be repaired in a safer, satisfactory manner without the medium of a "patch."

INTERESTING PARTICULARS were published concerning the manner in which the British steamer Southport was captured by the Germans and how it escaped by the skill of its engineers. While at Kusaie, one of the German islands in the Marshall group, the captain of the Southport learned of the declaration of war by being captured by the small cruiser Geier, a vessel now interned at Honolulu. The enemy, having dismantled and removed part of the vessel's engines, departed, leaving the captain in charge of the Southport to await further orders. The Germans had removed the eccentric rods of the intermediate and high-pressure engines, but neglected the rods of the low-pressure engine. Immediately they had gone, the chief engineer set about getting his engines to go somehow. The ahead low-pressure rod was left in place. The other was transferred to the ahead sheave of the high-pressure engine. In just over 10 days' time the engines were rigged up and working on the compound principle. They could, of course, only run ahead and once stopped could only be started again with difficulty, as they were liable to stick on the dead centers. But they served, and in 12 days' time the vessel arrived at Brisbane. This represents a voyage of about 2000 nautical miles, so that her speed in this crippled condition seems to have averaged 7 knots. Her normal speed is 9 knots.—The Engineer.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Design and Operation of Cleveland Municipal Plant

LOW ESTIMATED COSTS OF GENERATION; INTERESTING DESIGN AND OPERATING FEATURES

ON July 20, 1914, the new municipal lighting station at Cleveland, O., known as the East 53rd Street Station, was placed in operation. This plant, which has a rated capacity of 25,000 kw., is considered the largest central station ever built by any municipality in this country and is intended not only to supply electric current for street and commercial lighting, but also for power. The rates charged for service range from a maximum of $0.03 per kw.-hr. to a minimum of $0.01.

Estimated results to be secured from this plant are based upon an annual output of 60,000,000 kw.-hr. and with fixed charges based upon a total plant investment of $3,000,000. Fixed charges amounting to 9 per cent of this investment would equal $0.0045 per kw.-hr. Cost for coal is estimated at $0.002 per kw.-hr.; station costs exclusive of coal, at $0.0015; distribution costs exclusive of fixed charges at $0.004; administration charges at $0.0005 and profits at 8 per cent on the investment at $0.004. This makes an average price of $0.0165 per kw.-hr. generated, and from the 3 months' operation of this station, together with results of tests conducted, indications are that these results will be secured.

In Table I are shown the operating and maintenance

TABLE I. EAST 53RD STREET POWER STATION REPORT, AUGUST AND SEPTEMBER, 1914

OPERATION	AUGUST	UNIT COST	SEPTEMBER	UNIT COST
LABOR	$1498.48	$0.0018	$1,573.00	$0.0017
SWITCHBOARD ATTENDANCE	332.80	0.0004	380.00	0.00042
OIL, PACKING AND WASTE	....	....	66.89	0.00008
SUNDRY EXPENSE	....	....	10.46	
COAL	2,666.30	0.0033	2,415.69	0.0026
MAINTENANCE				
CONDENSORS, PIPING, ETC.	5.48	....	....	....
TOTAL OPERATION & MAINTENANCE	$4,543.26	$0.0056	$4,446.04	$0.0048
TOTAL KW-HR. GENERATED	809,120	....	914,850	....

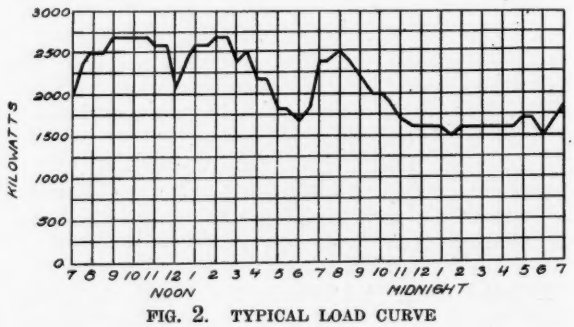


FIG. 2. TYPICAL LOAD CURVE

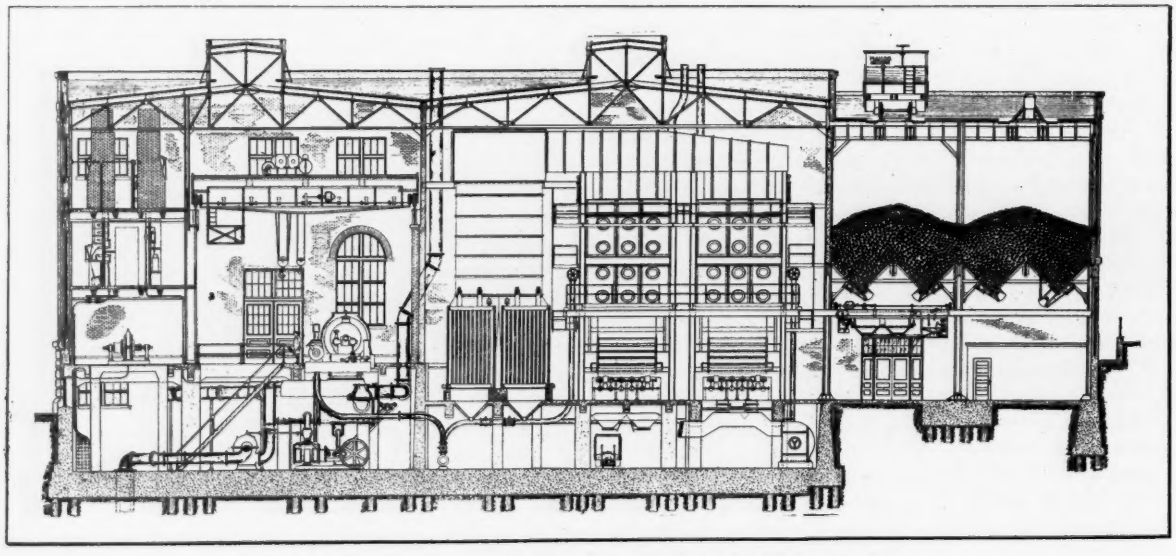


FIG. 3. CROSS SECTION OF CLEVELAND MUNICIPAL LIGHTING PLANT

*From a paper by Frederick W. Ballard before The American Society of Mechanical Engineers.

costs of the station for the months of August and September, 1914. During this period, the load carried was less than 1/5 of the total rated capacity of the station, and as a result the figures representing unit costs for the various items of labor, maintenance, fuel, etc., are considerably higher than it is expected will be obtained when the station is running at its rated capacity.

That an average load factor of 40 per cent will be secured on this station when the load is built up to its ultimate capacity seems to be assured.

A typical load curve is shown in Fig. 2. In this curve the peak load is shown to be only 2700 kw.; but with a load factor of 80 per cent based on the peak load, there is a total output on the generating station of 51,925 kw.-hr. If these conditions can be maintained, or

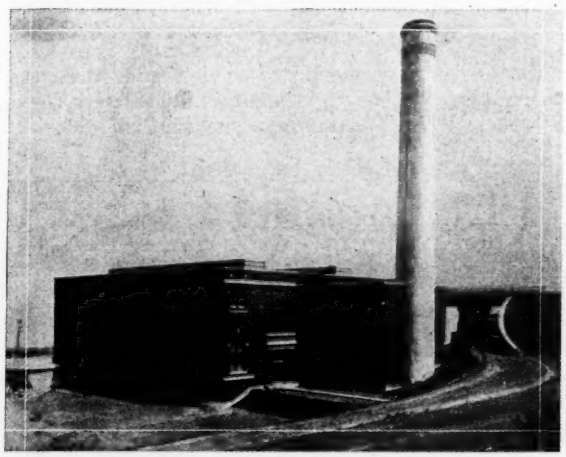


FIG. 4. EXTERIOR VIEW, CLEVELAND MUNICIPAL LIGHTING PLANT

even approximated, when the load on the station has been built up to its ultimate capacity, the load factor will be considerably greater than 40 per cent.

Design of Plant

In considering the location of this station, more attention was given the question of economical and convenient coal delivery and water supply than its proximity to any future load.

Cooling water used in the surface condensers of this plant is obtained from the City Water Works aqueduct and after being here used is delivered to the suction chambers of the pumping engines supplying the city with water. It was found that, due to the large quantity of water passed through these condensers, its temperature is raised but little.

As shown in Fig. 3, coal is delivered overhead by railway cars, and discharged by gravity into bunkers which have a capacity of 3400 tons. From these bunkers it is drawn through gates under pneumatic control into an electric telpher, which moves back and forth from under the bunkers on the track leading out over the stoker hoppers. The coal hopper on this telpher is carried on scale beams and the weight of the coal, and the time of delivery is carefully recorded.

Special features in connection with the design of this station different from standard practice, are as follows: The exclusive use of motor-driven auxiliaries throughout the plant; use of large boiler units with high steam pressure; use of economizers of much greater capacity than ordinarily installed; new arrangement of coal handling apparatus; use of both forced and induced draft with practically atmospheric pressure in the combustion chamber; automatic control of furnace conditions; simplicity of the piping layout, due to motor-driven auxiliaries; and the use of an auxiliary steam

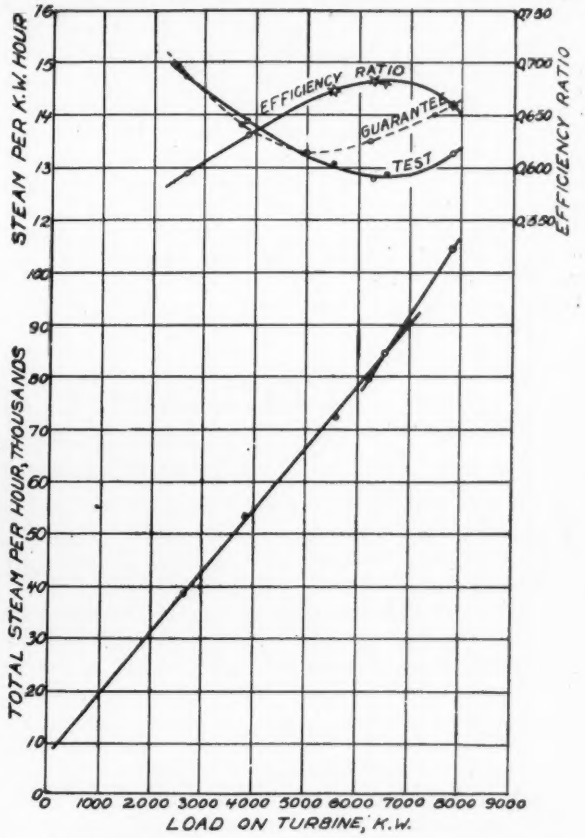


FIG. 5. RESULTS OF TESTS ON 5000-KW. STEAM TURBINE

turbine for driving the auxiliary motors. This turbine is supplied with a jet condenser, whose cooling water is the boiler feed water before going to the economizers.

Use of large boiler units with high steam pressure was decided upon and as a result, the boilers installed have a heating surface of 10,000 sq. ft. each and are designed to carry a working pressure of 275 lb. with a superheat ranging from 125 to 150 deg. F. They are equipped with Taylor underfeed stokers and are intended to be capable of operating up to 300 per cent of rating.

The use of both forced and induced draft contributes greatly to the flexibility of the installation, and makes it possible to carry practically a balanced pressure in the combustion chamber, thus avoiding the leakage of air through the settings. The motors on the forced draft fans are automatically controlled by the boiler pressure, while the induced draft fans are under manual control.

All steam piping is quite simple because outside of the auxiliary turbine, and the emergency equipment consisting of a steam turbine exciter and a turbine-driven feed pump, steam will be used only in the main gen-

erating units. The plant is so arranged that each battery of 2 boilers is opposite one turbine, the steam lines from the boiler going directly to the header from which a short branch is taken to the turbine. This header is capable of being cut into 3 sections by means of Hopkinson-Ferranti valves, whose interior is shaped like venturi nozzles, but which will carry an amount of steam equal to the full capacity of the pipe with practically no reduction in pressure. The main steam header is located in the boiler room basement near the floor, and the piping arranged in such a manner as to drain to this header from all directions. This header is 135 ft. long, and designed for a minimum of expansion which would effect a lateral movement in the branch pipes, and is divided in the middle by a loop for taking up expansion, which consists of 2 short headers, carrying 4 small U-shaped pipes of only ½ the diameter of the main. Two halves of the main header are then anchored securely at their central points, and carried on rollers from this point in both directions. This then divides the main header in such a way that at no place would the movement caused by expansion be more than that due to the expansion in ¼ its length. The main steam header is only 14 in. in diameter, and is composed of ⅝-in. thick steel pipe with welded necks and flanges. The branch pipes contain no fittings, except the valves which are of heavy cast steel. All turns are of long bends, and all sections have welded flanges.

All feed water pumps are of the centrifugal type, 2 of which are motor driven. One is steam turbine driven, and is designed for emergency purposes, and for operation where no electric current is available. This pump is arranged with governor control for constant pressure, and is therefore capable of being used in connection with either of the motor-driven pumps and to supply water to the boilers only when the demands are in excess of the capacity of the other pump.

Turbine Tests

Results of tests conducted to determine the steam consumption, efficiency and operating characteristics of the steam turbine generators are shown in Fig. 5.

Practical Electrical Engineering

Alternating-Current Series Arc Lighting Systems; Induction Motor Panels; Storage Battery Switchboards

DIRECT-CURRENT series arc-lighting systems using a series generator as the source of power, are practically obsolete. The series alternating-current lighting systems using regulating transformers were the logical development; but, owing to the lower efficiency of the alternating-current arc lamps, the combination of an alternating-current supply circuit, a regulating transformer and a mercury rectifier for supplying direct-current has been developed. A complete outfit of such a design, together with its control board is shown in Fig. 4. The mercury rectifier is mounted in the same case with the transformer and the control panel is located in close proximity. The connection diagram of this system is shown in Fig. 5.

Although this article is primarily devoted to the subject of switchboards, to make the details of this system more clear, a description of a mercury-arc rectifier may be useful. The rectifier bulb is a pear-shaped vessel about 7 in. at its greatest diameter, with 4 terminals or electrodes; the 2 upper electrodes being the anodes which are connected to the secondary winding of the transformer and the 2 lower electrodes are the cathodes which are connected to the direct-current circuit through the starting transformer. The active circuit is from the negative electrode continuously to one or the other electrode according to which is, at each instant, of positive potential toward the negative electrode. The conducting path is automatically shifted from one of the positive electrodes to another with cyclic variations in the e.m.f.

The bulb is mounted in a cradle so that it can be tilted in order to start it in operation and is filled with a highly attenuated vapor of mercury, which like other metallic vapors, is an electrical conductor under some conditions; the graphite or positive electrodes are immersed in this vapor. Current can readily pass from either of the solid electrodes to the mercury vapor; but if an attempt is made to reverse the direction of flow so that the current tends to pass from the vapor to the solid electrodes, there is an apparent resistance at the surface of the electrode which entirely prevents the flow of current.

Control panels for the rectifier outfits are generally made for 25, 35, 50, 75 and 100-lamp circuits. The 3 smaller panels are similar and each contains an ammeter, 3 oil switches, fuse blocks and fuses, the bulb tilting handle, an indicating lamp in series with the circuit, and a ground detecting outfit. A high-tension ammeter is located at the top of the board immediately below the indicating lamp, and is connected to the direct-current lamp circuit.

The lower oil switch is double-pole and is used to control the primary circuit; suitable fuses are also provided in the primary circuit. One upper oil switch controls the lamp circuit and is known as the line switch, while the other is a starting switch used for short-circuiting the load. The tilting handle for starting the rectifier extends through the panel. The panel for the larger capacities contains the same apparatus as the smaller panels except that one of the upper oil switches has 2 handles, one short-circuiting the entire load circuit and the other short-circuiting the bulb only; the latter is the starting switch. Figure 6 shows the relative efficiencies of various systems of series arc lighting. An annunciator relay notifies the attendant of any interruption in the lighting circuit, an interruption causing the relay immediately to close a bell circuit.

In alternating-current series incandescent lighting systems, tungsten lamps are used, all of which have the same current rating, although the candlepower may vary. The current is maintained at a constant value, while the voltage varies with the number of lamps burning, and is regulated by an auto-transformer with 8-point hand-operated receptacles for each circuit. Each

lamp is provided with an automatic cutout so that the circuit will not be interrupted if one or more lamps burn out. In case of a reduction of the number of lamps burning on the circuit from any cause, the receptacle can be changed to give the proper voltage for the number of lamps remaining in circuit.

Induction Motor Starting Panels

Figure 1 shows 2 types of General Electric motor-starting panels for use with polyphase-induction motors. Modern engineering practice includes the use of such panels for motors of any considerable size as all controlling and protective devices and indicating instruments are mounted and held in the best positions for efficient service.

Ratings for induction motor panels depend upon several factors. The apparent efficiency of an induction motor of given horsepower and voltage varies somewhat

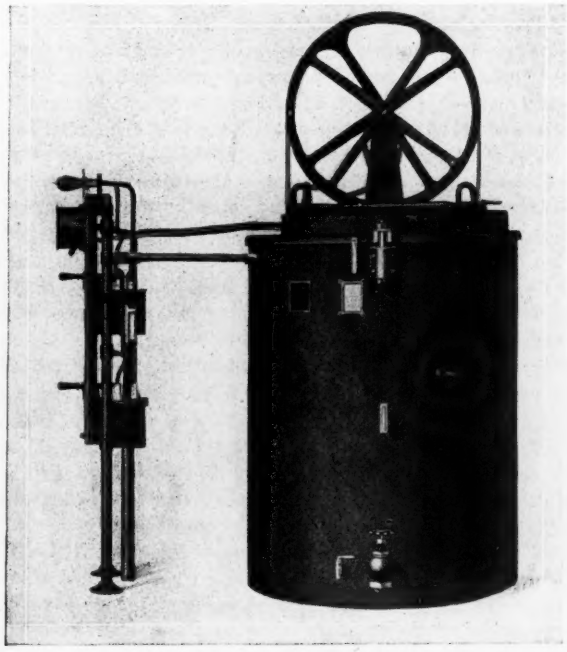


FIG. 4. REGULATING TRANSFORMER AND MERCURY RECTIFIER SET

with the speed for which the motor is designed, so that panels having a given ampere rating cannot be given a corresponding horsepower rating which will be correct for all speeds. The ampere capacity of the panel needed for a given motor may be determined by the following formula:

For motors with 25 per cent overload guarantee:

Ampere capacity of panel = (hp. × 746 × 1.25) ÷ (1.73 × volts × efficiency × power factor) = (hp. × 539) ÷ (volts × efficiency × power factor).

Storage Battery Switchboards

Switchboards for storage battery purposes differ in many respects from those used for light and power only. Figure 8 illustrates an Electric Storage Battery Co.'s switchboard for small plants, the arrangement of which permits the lights to be run from the battery only, from the generator while charging the battery, from the battery and generator in parallel, the battery assisting the generator, or from the generator alone. An automatic cutin and cutout switch is mounted on the panel so that in the ordinary operation of the plant, no hand manipulation of the switches is necessary except the adjustment of the generator current by means of the field rheostat.

This board has a rated capacity of 30 amp. at from 32 to 42 v., and is equipped with double-pole generator and battery switches, an amperehour meter and an ammeter, pilot light socket, automatic switch connected in the generator circuit which automatically connects

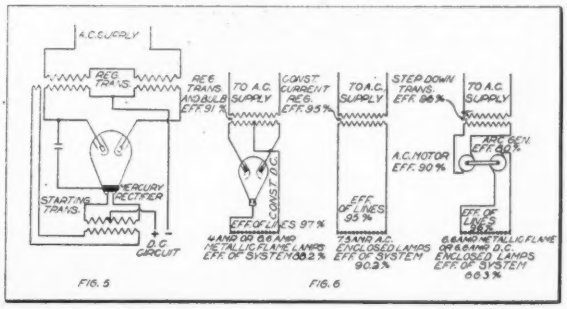

A.C. SUPPLY
REG. TRANS.
STARTING TRANS.
MERCURY RECTIFIER
D.C. CIRCUIT
FIG. 5
REG. TRANS. AND A.L.B. EFF. 91 %
TO A.C. SUPPLY
CONST. CURRENT REG. EFF. 95 %
CONST. D.C.
EFF. OF LINES 97 %
4 AND OR 6.6 AMP. METALLIC FLAME LAMPS EFF. OF SYSTEM 88.2 %
TO A.C. SUPPLY
EFF. OF LINES 95 %
7.5 AMP. A.C. ENCLOSED LAMPS EFF. OF SYSTEM 90.2 %
STEP DOWN TRANS. EFF. 98 %
A.C. MOTOR EFF. 90 %
TO A.C. SUPPLY
A.C. GEN. EFF. 90 %
EFF. OF LINES 98 %
6.6 AMP. METALLIC FLAME OR 6.6 AMP. D.C. ENCLOSED LAMPS EFF. OF SYSTEM 86.3 %
FIG. 6

FIG. 5. DIAGRAM OF CONNECTION OF A MERCURY RECTIFIER

FIG. 6. RELATIVE EFFICIENCIES OF VARIOUS SERIES ARC LIGHTING SYSTEMS

the generator to the line when the generator voltage rises to proper value and opens on a small reverse current. The balance of the equipment includes a generator field rheostat and a ground detector.

The amperehour meter indicates at all times the current taken out of the batteries and also indicates in one direction from full charge to discharge and in the reverse direction when charging. There is a contact locat-

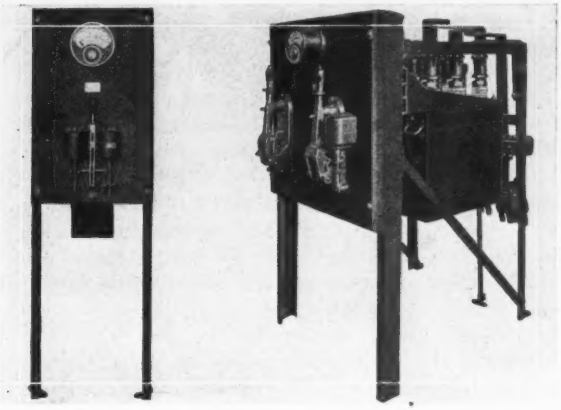


FIG. 7. POLYPHASE INDUCTION MOTOR STARTING PANELS

ed at full charge which actuates a bell or other signalling device; the instrument also shows when the battery needs to be charged and the rate of charging.

In the majority of cases, the engine and generator are run and the battery charged only in the daytime, and the current for the lights during the evening hours is taken from the battery exclusively. This method of operation is by far the most convenient and is the one for which this board is designed.

To charge the battery requires a voltage higher than the normal lamp voltage, and if the lamps are burned continuously under this voltage they will be abnormally bright and their life shortened. When it is necessary to burn many lamps and to charge the battery at the same time, it is customary to provide some means to

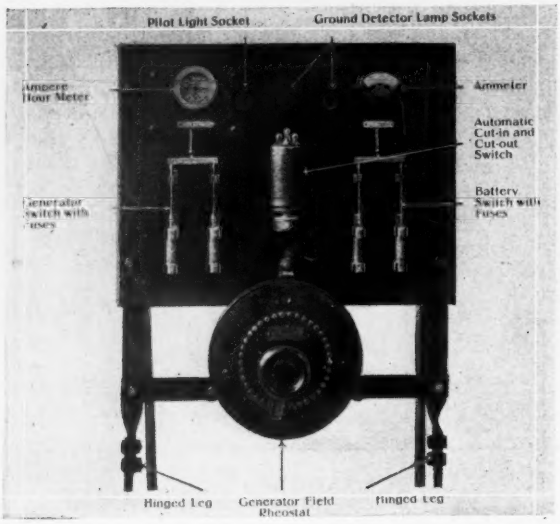


FIG. 8. STORAGE BATTERY SWITCHBOARD FOR SMALL PLANTS

reduce the charging voltage to the proper value of the lamps, which is approximately 32 v. To accomplish this, counter electromotive force cells may be connected in the circuit while charging, or a switch may be provided by means of which the lighting circuit can be temporarily connected to 13 cells of the battery instead of the 16 cells included in the equipment.

VOLUME 1 OF THE Transaction of the International Engineering Congress, will comprise a unique series of papers on the engineering of the Panama Canal. The various topics and subdivisions of the work have been arranged by Colonel G. W. Goethals, Chief Engineer of the Canal, and now Governor of the Canal Zone. Colonel Goethals has also selected the author for the treatment of each paper, and he will himself contribute the introductory chapter. The various authors are in general the officers who were in direct charge of the actual work of construction, and the collection of papers thus becomes a first-hand account of the engineering of the Panama Canal, written by the men who were in immediate and responsible charge of the undertaking.

The transactions of the Congress as a whole will include from 7 to 9 other volumes, covering all important phases of engineering work.

Membership in the Congress with the privilege of purchasing any or all of the volumes of the proceedings is open to all interested in engineering work. For full particulars apply to W. A. Cattell, Secretary, 417 Foxcroft Bldg., San Francisco, Calif.

AN AVERAGE day's work for a fireman on a large locomotive is to handle 25 tons of coal at the rate of about 5 15-lb. shovelfuls per minute of a 10-hr. day.—Compressed Air Magazine.

Notes on Economizer Operation

WE frequently come upon conditions in the installation or operation of vessels of all sorts, which though apparently unimportant, prove ultimately to contain the elements of great danger. A recent accident to a large economizer which fortunately did not prove serious except to the vessel itself has brought this fact home so forcibly that we believe the lesson taught will be of interest to our readers.

The plant in question contains 2 groups of boilers, an equal number in each group. Half the boilers discharge their products of combustion into one stack, while the remainder are served by an adjoining one. The whole arrangement is symmetrical, so that the boiler house contains practically 2 duplicate plants. Had this duplication been absolutely complete, with no interconnection, it is possible that the circumstances to be described might have been avoided.

The boilers were fed through 2 large economizers, one located in the flue between each group of boilers and its stack. Each large economizer was made up of 2 smaller ones placed end to end in the same setting and arranged so that they operated as a single unit. Feed pumps were provided for both of the large economizers, and water was pumped through them into a single feed main, running the length of the boiler house. All boilers of both groups were fed from this line. Provision had been made through valves to divide the feed line in half, letting one economizer feed into each half, and so serve to heat the feed for the group of boilers which furnished the hot gases for its operation but this sectionalization had not been thought necessary prior to the accident.

Early one morning a rumbling was heard at the hot end of one of the economizers, which the attendant interpreted as meaning that the vessel was overheated. A connection had been placed on the pipe between the 2 sub-groups of this vessel so that the feed might be bypassed around the colder section and through the hotter one only. The attendant attempted to open the valve so as to bypass the feed as described above, when there occurred a violent and sudden rupture of this valve, together with the rupture of several tubes and headers in the economizer itself. These ruptures were, however, confined to the "hot" half of the vessel, and fortunately the man was not injured.

Investigation showed the initial cause of the trouble to come from the corrosion of an iron gate valve in the line connecting the economizer with the feed main. The nut which fastened the gate wedge of the valve to the spindle had so far wasted away from the attack of the hot feed water that it failed, permitting the wedge to fall into the closed position and interrupt the flow of water through the vessel. As the failure probably happened at night when the boilers were but lightly loaded, the fact was not noticed at once. Enough feed water easily passed into the feed main through the other economizer to supply the demand, at the low rate of steaming, of both groups of boilers. The isolated economizer, however, heated up when the circulation through it was destroyed, and in all probability steam was formed, which would account for the rumbling that disturbed the attendant. Then when the first of the relatively cold feed was bypassed into the hot and perhaps partially

steam bound vessel, the inevitable water hammer occurred, rupturing the valve and tubes as we have mentioned. That such was the case is further evidenced by the condition of the pressure gage attached to the vessel after the accident. This had been subjected to so violent an over pressure that the pointer had been overthrown with force enough to bend it against the stop pin. Only an impulsive force of the nature of a water hammer could well have been the cause of the bending, for the safety valves on the vessel were in working order and set to relieve at a pressure far below the upper limit of the gage, but of course could not instantly relieve the great pressure of a water hammer in the short time necessary for its development and subsidence.

In a sense the stage was set for this accident when the 2 boiler groups, each with its own stack, economizer feed pump, etc., were tied together through the common feed main. Had the feed line been sectionalized, then when the outlet valve on one of the vessels failed from corrosion, the fact would have soon been noted by a lowering of the water level in the boilers in spite of efforts to maintain it. The speeding up of the feed pump would have caused the economizer relief valve to operate, and so have given warning that the stoppage was between the economizer and the boilers. It seems probable that under such circumstances steps could have been taken to obviate the trouble before it had advanced far enough to be dangerous. With the feed line not sectionalized, however, the danger stage was really reached before any warning was received. We have previously pointed out that the formation of steam in an economizer is of itself a dangerous condition, since the tubes are attached to the headers by pressed fits, and a little expansion of the top headers relative to the tubes would suffice to permit the blowing off of the top boxes at or below the pressure at which the safety valves are set.

The practice of attempting to cool off a cast-iron vessel suspected of being overheated by passing relatively cold water through the *hottest* part of the structure must of course be condemned at once. The proper procedure in such a case would be to close the dampers shutting out the hot gases, and passing them to the stack by way of the bypass flue at the first suspicion that overheating had occurred. That is what the bypass flue is provided for. All men about a power house with authority to open valves should understand this. Then, when the *supply of heat* has been cut off, the flow of water should be stopped, and the vessel allowed to cool off completely before making any further attempt to investigate the trouble or determine the extent, if any, of the damage.

Corrosion of the iron valve was not an unusual occurrence considering the service it had to perform. Brass has long been recognized as far more suitable than iron for service on feed lines or other portions of the pipe system where hot water had to be handled. It is doubtful if the saving in first cost of the iron fittings is justified where reliability in service is of importance.—The Locomotive.

SAFETY ENGINEERING is the name of the reorganized Insurance Engineering Magazine. The field is prevention of accident from any cause, and the treatment is timely and interesting. The office of publication is at 80 Maiden Lane, New York City.

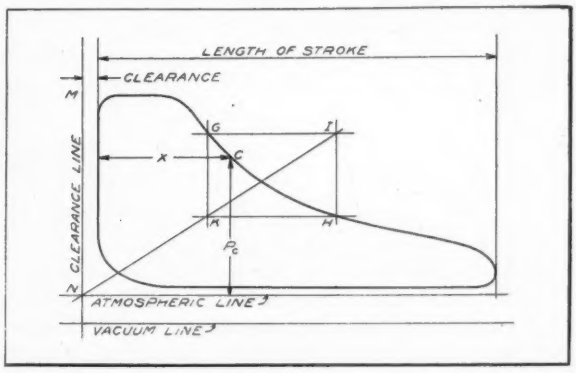
Steam Consumption Calculation

METHOD OF DETERMINING STEAM USED PER INDICATED HORSEPOWER-HOUR FROM INDICATOR DIAGRAM

KNOWING the length of stroke in feet, the area of the piston in square feet and the number of revolutions per minute, we can, from the data found on an indicator card, calculate the consumption of steam per indicated horsepower-hour of an engine.*

In order to carry on our calculations, it is necessary to determine the mean effective pressure and the percentage of clearance, the former being found by dividing the area of the card by its length and multiplying the quotient by the scale of the indicator spring used.

Percentage of clearance may be found as follows: Select any 2 points on the expansion curve, such as G and H in the accompanying figure, and through these points draw G I and H K respectively, each parallel to the atmospheric line. At G drop perpendicular G K and at H erect perpendicular H I, forming the rectangle



INDICATOR DIAGRAM SHOWING METHOD OF LOCATING CLEARANCE LINE

H I G K. Join I and K by a diagonal and extend this until it intersects the atmospheric line at which point erect perpendicular N M, thus establishing the approximate clearance line. This method of locating the clearance line is applicable only when it is known that the expansion line is of nearly the correct form. Measure the diagram, in inches; divide by the length of the diagram, in inches; multiply by 100 and the result is the percentage of clearance.

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*Let p = mean effective pressure, pounds per square inch from indicator diagram.
l = length of the stroke of the engine in feet.
a = area of the piston in square inches.
b = percentage of clearance to the length of the stroke.
c = percentage of stroke at any point in the expansion line.
n = number of revolutions per minute; and 120n = number of strokes per hour.
w = weight of a cubic foot of steam having a pressure as shown by the indicator diagram corresponding to that at the point in the expansion line selected for c, pounds.
w^1 = weight of a cubic foot of steam corresponding to the pressure at the end of compression, pounds.

Then the number of cubic feet per stroke = la (b+c) ÷ 100 in the clearance and piston displacement volumes (to c).

Weight of steam per stroke, pounds = law (b+c) ÷ 100.....(1)

Volume of the clearance, cubic feet = lab ÷ 100.

Weight of steam in clearance, pounds remaining in the cylinder = law^1 b ÷ 100.

Approximate net weight of steam used per stroke = [law (b+c) ÷ 100] − [law^1 b ÷ 100] = (la ÷ 100) [(b+c) w − bw^1].....(2)

Approximate weight of steam from diagram per hour = (120 nla ÷ 100) [(b+c) w − bw^1].....(3)

Indicated horsepower for a double-acting engine = 2 plan ÷ 33,000 (4)

Steam consumption per indicated horsepower is (3) divided by (4), or = 137.5 ÷ p [(b+c) w − bw^1].....(5)

Select any point C on the expansion line, lay off X and express this as a percentage of the length of the card. Measure P_c in inches, multiply by the scale of the indicator spring used and the product will be the pressure at point C.

We may now obtain the number of cubic feet per stroke in the clearance and piston displacement volumes up to C by dividing the product of the length of stroke in feet times the area of the piston in square feet times the sum of the percentage of clearance and the percentage of stroke up to C, by 100. Multiplying the quotient obtained by the weight of a cubic foot of steam having a pressure equal to that at C, we have the weight of steam per stroke in pounds.

Volume of the clearance space in cubic feet is equal to the quotient obtained by dividing the product of the length of the stroke in feet times the area of the piston in square feet times the percentage of clearance, by 100, which when multiplied by the weight of 1 cu. ft. of steam corresponding to the pressure at the end of compression will give us the weight of the steam in the clearance space, or that remaining in the cylinder after the piston returns to the end of its stroke.

Subtracting the weight of the steam in the clearance space from the weight of steam used per stroke, we have the approximate net weight of steam per stroke, which when multiplied by 120 times the number of revolutions per minute will give us the approximate weight of steam per hour.

We know that the indicated horsepower of a steam engine is equal to the quotient of 2 times the mean effective pressure times the length of the stroke in feet times the area of the piston in square inches times the number of revolutions per minute divided by 33,000, so that the total steam consumption per indicated horsepower-hour is equal to the approximate weight of steam per hour divided by the horsepower or, 137.5 divided by the mean effective pressure times the difference between the product of the sum of the percentage of clearance plus the percentage of stroke at C times the weight of 1 cu. ft. of steam having a pressure as that of C, and the percentage of stroke times the weight of 1 cu. ft. of steam having a pressure equal to that at the end of compression.

Any difference between the theoretical steam consumption calculated in the above manner and the actual consumption as determined by tests represents steam not accounted for by the indicator due to cylinder condensation, leakage of piston and valves, radiation, etc.

If the steam supplied to the engine is very wet, corrections for this moisture should be made.

Insulation

Cold Storage Ware Houses. By A. G. Solomon

IN considering refrigeration, whether it be ice making or cold storage, one of the most important subjects to be dealt with is the insulation. As there are a great many kinds of insulating material on the market, the greatest care must be exercised in the selection of the kind best suited to the conditions. It is generally safest and best to use none but such as is made and recommended by a reliable company. Those firms that specialize in any apparatus or material have means of testing and trying out whatever they recommend, and this is true of insulating material of many kinds.

The heat penetrating factor is, of course, the first to be looked into; but durability, cost and other questions must be considered as well, also the fire risk must not be neglected when a cold storage warehouse is under discussion.

It will readily be seen that there must be a limit to the amount of insulation used on the walls of a cold storage room. The heat leakage of 2 B.t.u. per sq. ft. per 24 hr. is the point aimed at when the average outside temperature is about 70 deg. and the room is to be held at 32; and with the same outside temperature and the room to be held at zero, the aim will be to allow only 1½ B.t.u. per sq. ft. per 24 hr. More insulation than what is required to meet these cases will be too costly to pay for the investment.

Insulating material should be as nearly fireproof as possible. In the construction of fireproof buildings, the kind of insulation and how it is used will have something to do with the insurance rate. A strictly fireproof cold storage can be built with an outer wall entirely independent of the inner wall except such few points as are used for tying the outer wall for rigidness.

Both walls are usually constructed of hollow tile, but sometimes brick is used for the outer wall. From 4 to 8 in. space is left between the 2 walls and this is filled with granulated cork or mineral wool. This construction is considered as near perfectly fireproof as possible especially if the insulating material be mineral wool. The inner surfaces of the inner wall are covered with 2 or more layers of cork board and finished with cement plaster. The partitions are made of hollow tile with one or more layers of cork board and cement plaster.

Heat leakage through walls of this kind is never more than 2 B.t.u. per sq. ft. in 24 hr., and is generally less.

Common wooden structures often used for ice houses or cold storage have a 6-in. space next to the outside wall which is filled with sawdust, shavings, cork or other insulating material. The outer wall is made of 2 layers of 1 or 2-in. matched boards with insulating paper between. The inside wall is made of one thickness of 1-in. matched boards, then an air space of from 2 to 6 in., then 2 layers of 1-in. matched boards with paper between. Wherever paper is used, it must be lapped over about 3 in. where the sheets come together, and at the corners it must be handled carefully or it will break. It is best to use an extra layer at all corners. This makes a very good building as far as heat leakage is concerned, but it is not at all fire or moisture-proof.

Where dead air space is used for insulating purposes, it is very important that the air is perfectly still; for if there are any air currents the space loses all its value as insulation.

No air space can be perfectly still where there is a difference of temperature on each side for the warm air will travel up and displace the cooler. The only way to approach the still air condition would be to confine very minute air spaces separately as by the use of some porous material. Instead of leaving an empty air space between 2 walls, more efficient insulation would be had if the space were filled with mineral wool or even shavings, provided that these materials would retain their elasticity and not collect moisture.

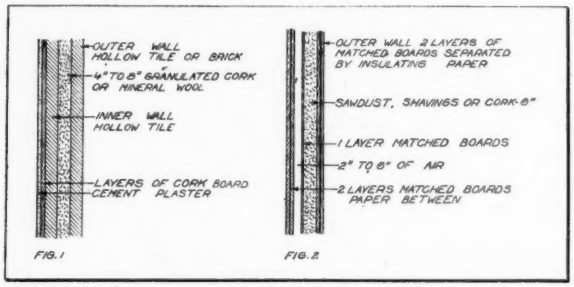

OUTER WALL HOLLOW TILE OR BRICK
4" TO 8" GRANULATED CORK OR MINERAL WOOL
INNER WALL HOLLOW TILE
LAYERS OF CORK BOARD CEMENT PLASTER
FIG. 1
OUTER WALL 2 LAYERS OF MATCHED BOARDS SEPARATED BY INSULATING PAPER
SAWDUST, SHAVINGS OR CORK 6"
1 LAYER MATCHED BOARDS
2" TO 6" OF AIR
2 LAYERS MATCHED BOARDS PAPER BETWEEN
FIG. 2

FIG. 1. FIREPROOF COLD STORAGE WALL
FIG. 2. WOODEN WALL FOR ICE OR COLD STORAGE HOUSE

It is claimed that a dead air space of 1 in. is just as good as one of 3 or 4 in.; for in either case, the imprisoned, still air will have a temperature of the average of the temperature on either side. If the outside temperature is 80 deg. and the room 20 deg., the temperature of the dead air space will be 50 deg.; and in figuring heat leakage this latter temperature is the one used.

Moisture is another enemy to proper storage of meats and other perishable goods; therefore, only such material should be used for insulation as will withstand moisture, cork being about the best in this respect. The inner surfaces of the rooms should be as nonporous as it is

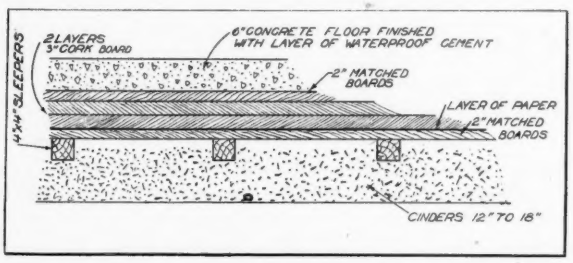

4"X4" SLEEPERS
2 LAYERS 3" CORK BOARD
6" CONCRETE FLOOR FINISHED WITH LAYER OF WATERPROOF CEMENT
2" MATCHED BOARDS
LAYER OF PAPER
2" MATCHED BOARDS
CINDERS 12" TO 18"

FIG. 3. GROUND FLOOR OF COLD STORAGE HOUSE

possible to make them. Ordinary cement and plaster are bad for moisture, and they also allow heat leakage. A smooth nonporous cement should be used or some high-grade enamel paint put over the plaster.

Sawdust and shavings used to be used extensively for insulation of walls and ice and brine tanks, but now they are seldom used. Both are excellent insulators, especially sawdust if perfectly dry; but moisture will find a way in and it will be only a short time till the heat resisting quality is almost entirely gone. Shavings are good in one particular, and that is their elasticity, which prevents settling. Cinders are also almost a thing of the past except as filling beneath the ground floor of buildings or under ice tanks.

The ground floor of cold storage houses is insulated in the following manner. A filling of from 12 to 18 in. of cinders, well packed, should first be put down. Then 4 by 4 sleepers upon which a flooring of 2-in. matched boards is nailed; next, paper; then 2 layers of 3-in. cork board laid in and also flooded with pitch or asphalt. The cork board should be laid with all joints broken. On top of this, another layer of 2-in. matched boards and then a 6-in. concrete floor finished with a layer of waterproof cement having a good smooth wear resisting surface. Some builders prefer to put the concrete directly on top of the cork board; but this is still a matter of dispute, as either way seems to have certain advantages.

Dryness is one of the main objects aimed at, so good drainage from the building should be provided.

An excellent insulation for the floors of sharp freezers or rooms that are held at an extreme cold temperature is put in as follows. On top of a 2-in. plank floor 4 by 4 sleepers are laid at from 3 to 6-ft. centers. The space between the sleepers is filled with granulated cork or with 2 layers of 2-in. cork board (laid in pitch). Then 2 layers of 2-in. cork board are placed on top with the

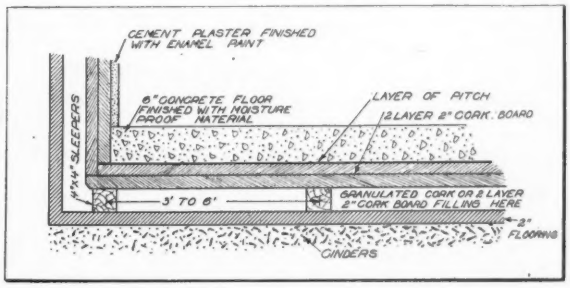

CEMENT PLASTER FINISHED WITH ENAMEL PAINT
6" CONCRETE FLOOR FINISHED WITH MOISTURE PROOF MATERIAL
LAYER OF PITCH
2 LAYER 2" CORK BOARD
4"X4" SLEEPERS
3' TO 6'
GRANULATED CORK OR 2 LAYER 2" CORK BOARD FILLING HERE
2" FLOORING
CINDERS

FIG. 4. INSULATION FOR FLOORS AND WALLS OF SHARP FREEZERS

joints properly broken. Pitch is flooded over the whole. A concrete floor is put over this and finished with moisture-proof material, the same as other floors.

The walls are constructed in the same manner except the covering. Good cement plaster is used and finished with enamel paint, which is nonporous and easily kept clean.

Partition walls between cold storage rooms do not need such good insulation and can be built of layers of cork board fastened to a suitable wall, which will insure rigidness. Or the partitions can be made of 2 by 4 studs covered with 2 thicknesses of matched boards with paper between and the space filled with granulated cork.

The ceiling of the top floor of cold storage rooms needs particular attention, as here the heat radiating through the roof has to be contended with; 2 by 12 joists with a 2-in. matched board floor underneath give the framework. The space between the joists is packed with granulated cork and 2 or more layers of cork board, laid in pitch, put on top. The roof should be at least 18 in. above this and should be provided with suitable ventilators. Ventilators should also be placed in several places in the ends and sides. This will allow for a free circulation of air. If air is not allowed to circulate, the space becomes hotter than the outside atmosphere owing to the sun's rays beating down on the roof.

The ceiling of the top floor rooms is finished with 2 layers of cork board with a coating of cement plaster and enamel paint.

Doors, Windows and Anterooms

The doors used in cold storage buildings must receive a good share of consideration, as they are a very important item. Properly constructed doors, together with their frames, are made and supplied by firms who have made a special study of this line of work. They are made of the best materials both regarding insulation and durability. When properly hung, they will keep tight for a long time and also be easy to open and close.

Doors and framing built by ordinary carpenters generally become a source of annoyance in a very short time, as they swell and have to be readjusted frequently. Some of this style doors never are tight, even when new.

Where several cold rooms open into one hall, it is a good idea to have the hall fitted with proper insulation and doors and have it refrigerated; in this way, a lot of heat is prevented from going direct into the rooms when the doors are opened. If the hall is not refrigerated, it should be insulated by the continuation of the same insulation used for the rooms.

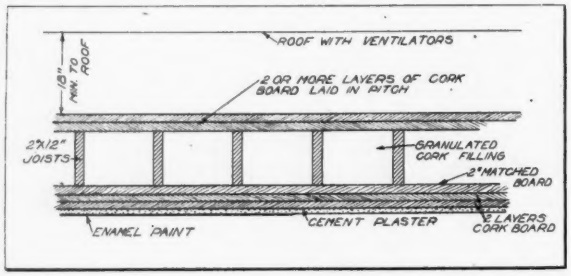


FIG. 5. INSULATION FOR CEILINGS OF COLD STORAGE ROOMS

Vestibules or anterooms are often used in connection with ice vaults and storage rooms.

Windows are not found in cold storage rooms as a rule; but when they are necessary, they should be made of 3 or 4 thicknesses of glass with air spaces between.

Ice and Brine Tanks

For insulating the bottom of ice or brine tanks, a filling of from 8 to 12 in. of cinders, well packed, should first be put down; then joists upon which a flooring of 2-in. matched boards is nailed; next, paper, and then 2 layers of 2-in. cork board laid in and also flooded with pitch or asphalt. The cork board should be laid with all joints broken. On top of this another layer of 1 or 2-in. matched boards is laid and given a good heavy coating of pitch. Then the tank is set in place. The bottom and sides and ends of the tank must be painted also. Around the tank is then built the wall to hold the side and end insulation. This is built of 2 by 4 studs covered on the outside with 2 layers of 1-in. matched boards with paper between. The space between the tank and outside wall should be from 8 to 12-in. and the granulated cork or other insulating material must be well packed to prevent future settling.

The best manner of insulating the top of ice tanks is a problem which has long puzzled engineers and insulating experts. The lids are made of 2 thicknesses of matched boards with 2 thicknesses of paper between and all parts of lids given 2 or 3 coats of good paint. The lids should be kept as snug a fit in the frames as possible without interfering with their easy removal. Whenever a lid is found to be broken or which does not fit properly, it should be repaired or replaced by a good one. A supply of lids in good condition should be on hand at all times. These lids we can call the ordinary insulation of ice tank tops.

Then we have on the market several different makes of blankets, mattresses and quilts for covering over the top of the lids. These coverings come in any size desirable and are made up mostly of canvas and hair felt or of material which contains little air cells, making a sort of dead air insulation.

When using insulating quilts on an ice tank, they are moved about in such a way that as much of the tank is kept covered as is possible without interfering with the work of the ice puller. They should not be allowed to become soaked with the brine or water and should be given a sunning once in a while to keep them fresh.

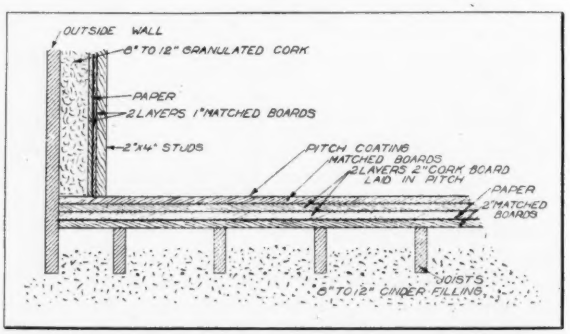


FIG. 6. INSULATION OF ICE AND BRINE TANKS

Some ice plants are operated during the night only during the winter season and repair work done during the day. Insulation covering is a good thing in such a case as it helps to exclude warm air from leaking through the small openings around the tank lids.

There are 2 materials that should never be used for insulating; namely, charcoal and cotton seed hulls. Both are dangerous fire risks and the insurance companies will object to their use. They are both good insulators but are also very inflammable. In the South, where cotton seed hulls are cheap and easily obtained, they have often been used as the end and side insulation of ice tanks. They are lasting and when once properly packed will not settle.

The use of moving pictures in the publicity field of the machine industry is not new, but examples of its extension are always of interest, and one firm in Hull, England, making oil-mill and other machinery for export, has a "private picture palace" for showing its machinery in operation under various circumstances. An important variation on this scheme is to send the films abroad, with or without a salesman, for the benefit of customers who might never have an opportunity to see the actual operation of the machinery in other countries.—Compressed Air Magazine.

Trouble with Water Jacket Piping

By Karl Hoffman

FIGURE 1 illustrates the arrangement of piping to supply the water to the jackets of 2 ammonia compression machines. Owing to the arrangement of the suction lines the angle valves V and V¹, for regulating the flow of water, are necessarily located as shown, instead of being screwed onto the nipples where the elbows E and E¹ are located.

The water supply, at a temperature of 53 deg. F., is obtained by connecting to a branch tee located in the discharge line of a triplex water pump. This was done to obtain the benefit of the lower temperature, for all of the water used in the plant is first pumped through a double-pipe ammonia condenser, which it leaves at a temperature of about 70 deg. F.

Owing to the branch tee being located close to the pump cylinders, trouble was had from the beginning by the water slopping over at the point P. Whenever the angle valves V and V¹ were opened to start the water circulating in the jackets, the air confined in the piping between the elbow X and these valves would rise to the surface in the form of bubbles, which displaced

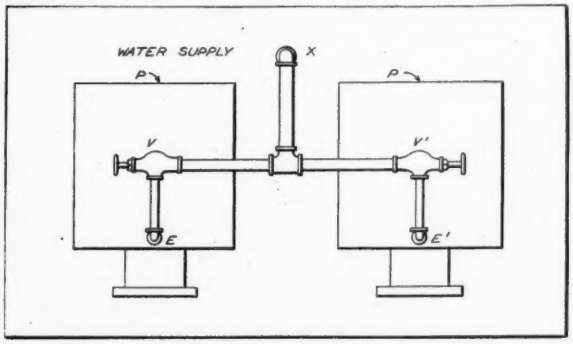


FIG. 1. ORIGINAL PIPING TO WATER JACKET

a certain amount of water and caused the slopping over at P. This part of the trouble could be overcome by opening the drain valve D, shown in Fig. 2, and allowing enough water to run out of the jackets to prevent this, when starting.

To do away with the inconvenience, and prevent the water from slopping over, which it did, at times, after the circulation was established, the operating engineer constructed the chamber C, which was screwed into the tee, which replaced the elbow X. The arrangement of parts is shown in Fig. 2, which is a side view of one of the compressor cylinders, and illustrates the manner in which the water is conducted to and from the jackets.

The engineer reasoned that the chamber C provided a space in which the air, being lighter than water, would collect. In order to keep the piping free from air, at all times, a ¼-in. pipe is led out of the top of the chamber to a point a little above the surface of the water in one of the jackets.

The ¼-in. valve is opened slightly to allow a small stream of water to flow continuously. Any air collecting in the chamber, C, finds relief by passing out with the water. The chamber, C, is proportioned to the cubic contents of all the piping between the elbow, X, and the angle valves, V and V¹. This was done to provide a space for all the air that might collect at this point after the water pump has been idle long enough for the water to drain out of the supply pipe. The other machine has a similar arrangement. Since the application of these chambers, no trouble has been experienced from this cause.

Figure 3 is an illustration of the manner in which the operating engineer of another compression plant located a thermometer to indicate the temperature of the water flowing to the ice cans. The storage tank is located too close to the ceiling to make it convenient to

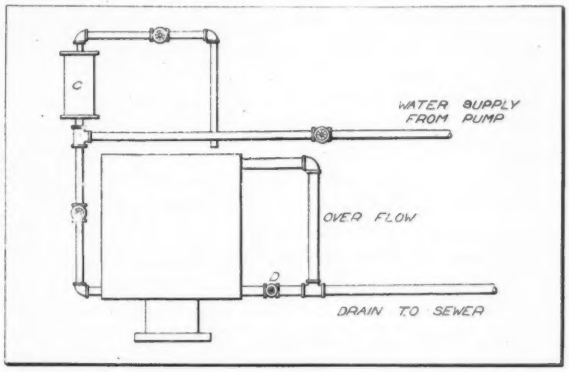


FIG. 2. PIPING ARRANGED TO REMOVE AIR

lower a thermometer into the water from the top of the tank. No provisions had been made close to the outlet for the location of an angle thermometer. The engineer having one at hand, with a straight stem, arranged the fitting and located it, as shown. This is a raw water plant, the water being pumped directly into the storage tank. The return line from the ice tank is continued, in the form of a coil within the storage tank, and by carrying the frost on the return lines past the storage tank,

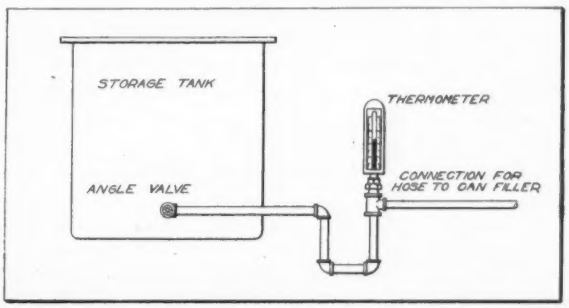


FIG. 3. LOCATION OF THERMOMETER IN LINE TO CAN FILLER

and still not allowing any liquid ammonia to enter the compressor cylinders, the temperature of the water is reduced considerably below the initial.

As this is a mixed plant, the arrangement is convenient to obtain the average temperature of the water flowing to the ice cans, in order to charge the tons of refrigerating effect equivalent to tons of ice made in the plant each day. The tee, where the thermometer is located, might have been placed where the elbow is, and the whole located nearer to the outlet, but as the storage tank, and all pipe and connections up to the hose connection for the can filler, are well insulated, the slight difference in location is not appreciable.

Vacuum and Atmospheric Pressures

By Eric H. Peterson

ALMOST every engineer has now and then to deal with problems related to vacuum and atmospheric pressure at different altitudes. Naturally, he looks into engineering handbooks or perhaps into a book of engineering thermodynamics, if such a book is at hand, but wherever he looks, he fails to find at a glance just what he is looking for; he will always have to do a lot of figuring, and even at that, the available data do not always suffice to do the figuring at the time needed.

To eliminate waste of time for this purpose I have prepared the convenient tables and chart given in the Practical Reference Tables which I have found very useful in my work, and which I hope and believe will be found useful and appreciated by most of the readers. In fact, I think these tables and chart ought to be on the trestle-board of every drafting room and engineer's office and they should be inserted in books on thermodynamics and especially in every engineering handbook.

Example for Using the Chart

Find pressure in pounds absolute, corresponding to 26 in. vacuum at an altitude of 2000 ft.

From the point 2000 on the altitude line, trace upwards to the barometric curve, then from this intersection horizontally to the right to the atmospheric pressure line, graduated in pounds per square inch, where we read 13.68, this being the atmospheric pressure in pounds per square inch at this altitude.

Then from the point 26 on the ordinate marked "inches of mercury" trace horizontally to the right to atmospheric pressure line, and we read 12.79, which is the pressure in pounds per square inch of a 26-in. mercury column or, in other words, the pressure in pounds per square inch that balances 26-in. vacuum at sea level. Now, the answer to the problem above, is the difference between the atmospheric pressure in pounds per square inch at the altitude given and the pressure in pounds per square inch caused by a 26-in. mercury column, or 13.68 — 12.79 = 0.89 lb. absolute per square inch.

At sea level, where the barometric pressure is 29.9 in. and the atmospheric pressure is 14.7 lb. per sq. in., 26 in. vacuum corresponds to 14.7 — 12.79 = 1.91 lb. per sq. in. absolute pressure, which can be read directly on the "comparison table of vacuum and absolute pressures at sea level."

On the chart can also be found the barometric pressure at any altitude embraced by the chart, for instance for 2000 ft. altitude, trace upwards to the barometric curve and from the intersection to the left to the ordinate marked "inches of mercury" and find 27.8 in. barometric pressure.

These examples are traced with arrow lines on the chart.

Liquid air now being produced abroad on the Linde and Claude systems amounts to more than 30,000 gal. hourly, which is used principally in the production of pure oxygen.

Restoring Shattered Confidence

A Lesson of the War.

By John H. Fahey*

SHOCKED as almost never before in our history by the terrific impact of an unexpected war, the country's business was almost prostrated. The unsettling character of this disturbance you well know; and yet within this short period the recovery from it has been little short of marvelous. Able and patriotic business men, and resourceful organizations of business men, did their full share, working shoulder to shoulder with the responsible heads of the Government in repairing the broken down machinery and in restoring shattered confidence.

That this great historical happening will have far-reaching results cannot be denied. What the ultimate effect will be depends largely on us as a people, on the wisdom of our statesmen and the courage and leadership of our business men. Perhaps this catastrophe has brought us to a keener realization of our common interest than ever before. The farmer and the worker have come to see their dependence on the transportation agencies and the business men and likewise there has developed an equally better understanding on our own part of our relation to these other great interests.

It seems clear that we are going further out into the world than ever before; that America and things American will be better known in lands where we have been almost strangers. In this evolution let us see to it that our America carries the impression we would like to have it convey, that it stands for liberty and justice and honest dealing. On no other basis can our influence be long sustained.

In the countries across the Atlantic now rent by strife, but a few months ago things of serious portent were developing. Violent social, racial and religious prejudices were aroused over projected reforms in nearly all of them. Even civil war threatened. But when the cataclysm came dissensions were forgotten over night. Rich and poor, high and low, came together in each nation in the common cause.

The example is sharply before us. Do we need any greater crisis than that through which we have passed so recently to make clear to all of us the necessity of real national co-operation and understanding? It is quite as patriotic, it is quite as much our duty, that in the blessedness of peace we should forget prejudices and partisanships and undertake to work together efficiently and persistently, supporting with all our energy that which makes for the greatness of the Republic and of its people.

As we go forward in this effort we will surely find that so far as business is concerned, unity of action and efficient organization will prove a great instrument for helpfulness and service. It is with this sense of service that we should support it and work for it,—for better business and a grander Republic.

No man can safely or wisely take all from and give nothing to his fellows or his community.

*President of the Chamber of Commerce of the United States.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Spraying System for Oil Engine

By Petrol

IT may interest some readers of Practical Engineer to know what has been done with our oil engine since it came from the builders. This engine is a horizontal single cylinder 27½ by 33 in. of 4-cycle type and operates on Illinois crude of about 31 gravity (Baumé).

The spraying device has been completely changed. Originally, the fuel was pumped through a spray plate, having holes of about 0.008 in. diameter, against the hot bulb end of the combustion chamber. This caused very high pressure on the fuel line and the small holes in the spray plate would often choke up by bits of packing from the fuel pump or other sediment and relieve a safety valve set at 1000 lb.

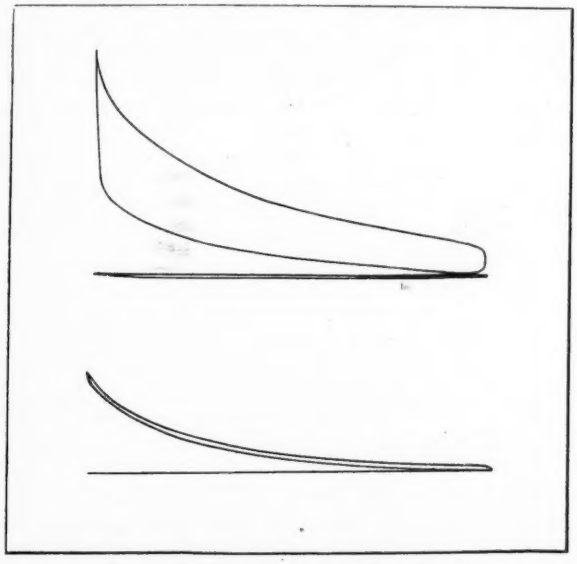


FIG. 1. CARDS FROM AN OIL ENGINE

When using this sprayer large quantities of carbon would collect in the vaporizer, more than a half bushel of this deposit would often be taken out 2 and 3 times in 24 hr. Our longest run with this sprayer was 89 hr. Aside from these troubles and delays the fuel consumption was very high, 1.2 to 1.4 lb. per hp.-hr. being about the average.

Among 15 of these engines situated in 8 different plants, all were giving about the same results, and after they had run about a year the master mechanic took the matter in hand and after a time perfected a spraying system which was put on all the engines and on some of them it has practically done away with the troublesome carbon deposit entirely, and on all of them it has reduced the fuel consumption over half, lowered the pressure in the fuel line to about 100 lb. and increased the power of the engine. The latter spraying device is shown in Fig. 2. The air line H is connected to an air tank which in turn is supplied by an air compressor, capacity of which is 12 cu. ft. per minute and is delivered at 115 lb. pressure.

Valve A is actuated by the crank E on the cam shaft. The lift of this valve is adjustable by the threaded rod F. This arrangement governs the pressure in the air tank as well as to give the right amount of air to the sprayer at the proper moment. C is the fuel valve; its stem is hollow, the oil passes inside the stem and out through 1/32-in. holes, which are drilled just inside of the seat. This causes a pressure on the fuel line and makes the governor effective. Valve B prevents oil and air from backing into the air line. Valve D is a quick closing valve, which avoids all pressure from explosions in the engine.

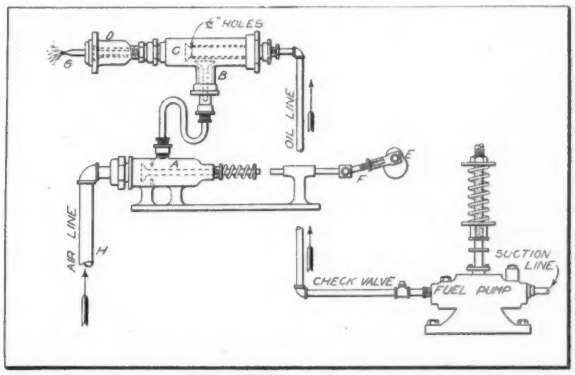


FIG. 2. SPRAY DEVICE FOR OIL ENGINE

The nozzle G is made of an old spray plate and a piece of ¼-in. brass pipe 3 in. long. The pipe is flattened enough at the end to allow an opening of about ¼ by 3/64 in. The pipe is screwed into the spray plate and the nozzle is complete. Numerous experiments have proven that this type and length of nozzle give the best results.

The valve setting of the engine was changed 5 deg. The exhaust valve opens 55 deg. ahead of the out center and remains off its seat for 267 deg. of the crank, and the inlet opens 25 deg. ahead of the in center and remains off its seat for 240 deg. of the crank. The fuel pump works simultaneously with the inlet air valve. Valve A of the sprayer opens just as the fuel pump completes its downward stroke.

I would be glad to read the experiences of others who are using oil engines.

Output of Internal Combustion Engines

VARIATION OF TEMPERATURE AND BAROMETRIC PRESSURE RESULT IN VARIATION OF POWER DEVELOPED

BY far the larger proportion of internal combustion engines have been installed in localities not far from sea level and where the climate is temperate, and under such conditions have proved their reliability. Experience has shown that they will work satisfactorily, and more or less continuously, with a mean effective pressure of 90-100 lb. per sq. in., at which load it is found that no undue wear takes place provided the parts are properly designed and regular routine practice observed in maintenance and adjustments. Accordingly, it has become recognized that 90-100 lb. per sq. in. is the full-load rating.

The climate of the British Isles and that of Western Europe generally, is almost ideal so far as the running of internal combustion engines is concerned, a fact which is not always fully realized when the question of installations in foreign parts is considered. In most other parts of the world the climatic conditions are not nearly so favorable, and the effect of high temperature or low barometric pressure (sometimes both) must be taken into account.

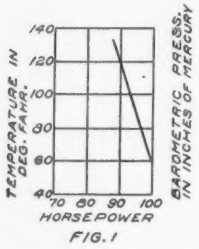


FIG. 1

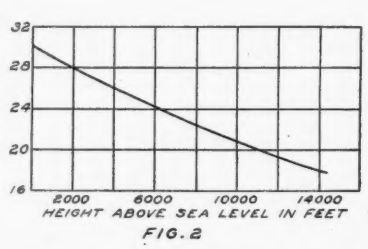


FIG. 2

FIG. 1. RELATION BETWEEN TEMPERATURE AND OUTPUT
FIG. 2. RELATION BETWEEN BAROMETRIC PRESSURE AND ALTITUDE

When the engine has to work at sea level in tropical countries, manufacturers usually make a reduction of 10 per cent of the normal rating in Great Britain. This plan gives satisfactory results, though, on purely thermal considerations, so large a margin is not always necessary. The reason for the reduction of output at high atmospheric temperatures is that the weight of air drawn into the cylinder is then less than at lower temperatures, and the indicated horsepower of an engine is directly proportional to the weight of air drawn into the cylinders, that is, it is inversely proportional to the absolute temperature of the air. On this basis, the curve in Fig. 1 has been prepared for an engine of 100 indicated horsepower at 60 deg. F., and from which we find that the air temperature must rise to 120 deg. F. before the indicated horsepower is reduced 10 per cent.

The reduction in output of an engine installed at a considerable elevation above sea level is much more pronounced, and it is rarely that sufficient allowance is made in this respect. Not infrequently it is assumed that the output must be reduced proportionally to the barometric pressure, but it has been found that this is inadequate as well as incorrect.

From Fig. 2, which shows the relation between barometric pressure and altitude, it is at once apparent how considerable is the effect of high elevation. But it is also necessary to remember that if the maximum indicated horsepower of an engine suffers a reduction, there is a simultaneous loss in mechanical efficiency.

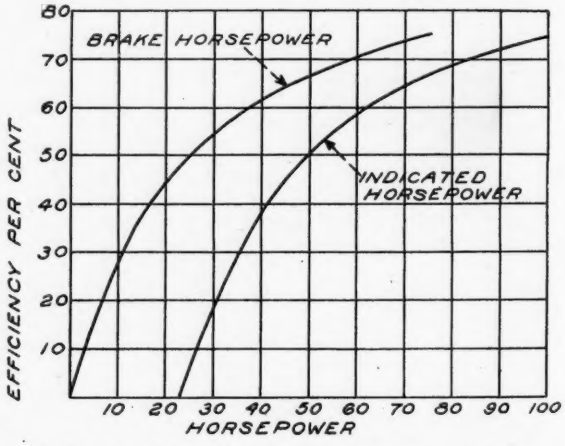


FIG. 3. RELATION BETWEEN EFFICIENCY AND POWER

Thus, in Fig. 3, the mechanical efficiency has been plotted against both brake horsepower and indicated horsepower of the engine whose maximum load is assumed as 100 i.hp., corresponding in this instance to 75 b.hp. From it are readily deduced the brake horsepower and efficiency corresponding to any indicated horsepower.—The Power User.

TWO ACHIEVEMENTS of the United States Bureau of Mines, which are now made public, are of special interest to the power and mechanical field. Both have been discovered by Dr. W. F. Rittman, Chemical Engineer of the Bureau, after many years of research, the work having been done at Columbia University in New York City.

The first of these is a method for the manufacture of gasoline from crude petroleum, which it is expected will increase the output of gasoline some 200 per cent.

The second is a method of manufacturing from crude petroleum what are known as toluol and benzol, both of which have heretofore been obtained from coal tar, and which are used in production of dye stuffs and high explosives. These have largely come from Germany as byproducts from coal, but the new process will make it possible to derive all the needed quantities of these 2 products in the United States, with some gasoline as a byproduct.

Dr. Rittman is applying for patent on these processes, in order to prevent any monopoly, but will dedicate them freely for the use of the citizens of the United States without royalty. The increase possible in the product of gasoline will go far to overcome the possibility of a shortage due to the increasing use of gasoline for internal combustion engines. As the value of the gasoline product amounts to some $150,000,000 a year, the importance of the discovery can be realized, and the second process will be of as great value in the dyeing and explosive industries as this first process is in those branches of trade where gasoline is essential.

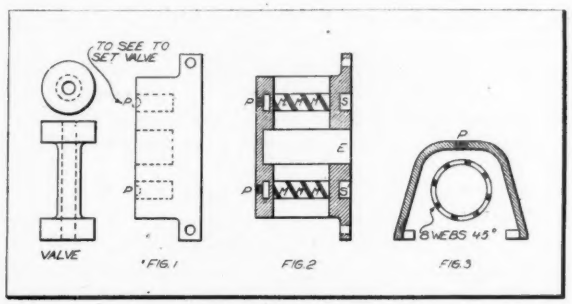
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Replacing a Meyer With a Piston Valve

THE ILLUSTRATION shows, Fig. 7, a tow boat, in which was installed a water-tube boiler, 2 yr. ago. It was formerly a noncondensing boat; but when the new boiler was installed, it was fitted up with condenser and the necessary auxiliaries for condensing. The writer, having installed the auxiliaries and being acquainted with the engineer and owners, was much interested in the success of the boat, so occasionally took a sail, and on one occasion was asked to suggest some means by which the excessive amount of oil could be kept out of the boiler. It had a large filter box of the approved marine type; but, as the engine required a large amount of cylinder oil, the filter box would not take it all.

The engine had a Meyer siding cutoff valve which was originally used with 90 lb. of steam pressure; with the water-tube boiler, the pressure was increased to 150 lb. This increase of pressure required much more cylinder oil for the Meyer valve than was formerly used,



F.G. 1. PISTON VALVE AND VIEW OF HALF THE CAGE
FIG. 2. LONGITUDINAL SECTION OF CAGE
FIG. 3. TRANSVERSE SECTION OF CAGE

the valve and seat being badly worn. In a short time, conditions became very bad in the boiler, due to excessive grease.

The writer suggested a piston valve for the engine, and a centrifugal pump direct-connected to a vertical engine, for a circulator in place of the duplex pump originally installed. The piston valve was installed a year ago and the centrifugal pump 3 months later.

The piston valve job was a little unusual around here, but was carried through as follows. The old valve was taken out, all measurements taken and the valve put back, so the boat was hauled off only a few hours. Drawings, patterns, and castings were made and the castings machined ready to install when the boat could again haul off. The new valve and cage were so designed that after 3/32 in. had been milled off the old seat, the valve ram at R, Fig. 6, would be turned halfway round, so the off-set would bring the new stem farther from the seat than the old main valve stem, the link remaining in the same line.

Figures 1, 2 and 3 show the construction of the cage, which was so designed that the combined area of the ports, M, was nearly 1½ times the area of the ports in the engine. This was done because of the webs; the intention was to use rings on the valve at first, but it was decided not to after the casting was made. The valve was designed as a plain slide valve, the piston valve being only a plain slide valve "rolled up"; but to get extra port opening on account of the webs, the valve was given less lap, both steam and exhaust. This was determined when it was put in, a piece of wood being used as a templet connected to the valve stem. The cage was finished to exact dimensions and the valve ground in a Bath grinder to insure a perfect fit, and then tested with cold water.

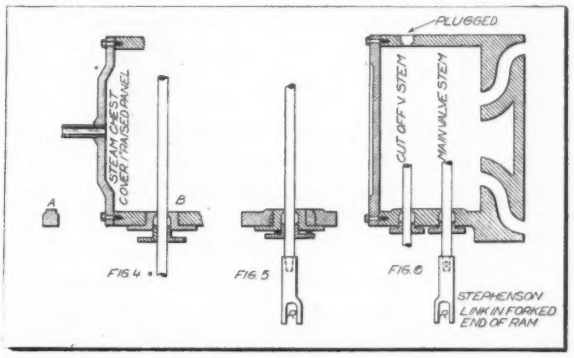


FIG. 4. PLUG AND RAISED PANEL COVER
FIG. 5. CROSS SECTION OF FINISHED GLAND
FIG. 6. ORIGINAL ROD AND GLAND ARRANGEMENT

A new stem was made, also a stuffing box, shown at B, Fig. 4, to be bolted on with the original gland studs. Two cast-iron plugs, shown at A, Fig. 4, were made to press into the original stuffing boxes.

The original steam chest cover had a sunken panel; but to allow for the extra depth of the cage, it was necessary to make a new one with a raised panel.

When the boat was hauled off, the seat was milled off to the right depth, with a portable machine, built for this class of work, and scraped to a true surface.

The old stuffing boxes were plugged and the hole for the new one drilled with a special tool, the new stuffing box setting up into the steam chest casting, Fig. 4.

The stuffing box was pressed in and bolted with the old gland studs. The cage and valves were put in, lined up and held with wedges while the holes were drilled for

the bolts to hold the cage in, Fig. 1. The cage was put in with a paper gasket, the valve gear connected up, valve and eccentrics set, the old cutoff eccentric rod removed, cover put on and the engine started, the time being 2 days and 3 hr., for the writer, helper, engineer and supervision of the shop foreman.

No oil was used after the first day's run, but it was afterwards found necessary to put extra bolts in the cage because expansion lifted the middle of the cage off the seat and blew the gasket. The new bolts were put

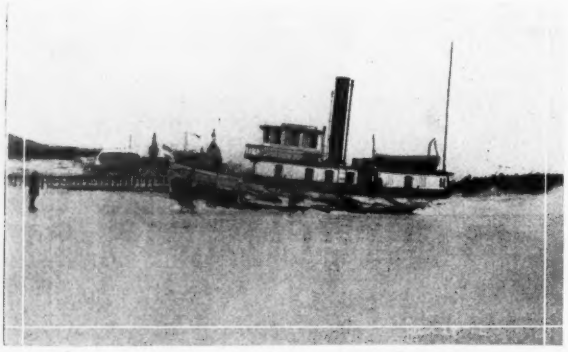


FIG. 7. TOW BOAT BREAKING ICE IN CAMDEN HARBOR

in the sides by means of drilling and spot facing, making special bolts. No gasket was used when the cage was put back. The engine has been blocked and tested and shows no steam leak.

The valve has been in over a year and has given no trouble other than the first, it uses no oil, and shows practically no wear. R. B. MAGUNE.

Examination Questions in U. S. Navy

FOLLOWING are some questions asked in the examination for the position of Warrant Machinist, in the United States Navy:

HANDWRITING AND COMPOSITION (VALUE 5)

1. Write a brief history of your engineering training and experience.
2. State briefly your ideas of the best methods of handling men.

ARITHMETIC (VALUE 10)

1. A feed tank is 3 ft. 2⅓ in. by 7 ft. 9 in. by 4.9 ft. How many gallons of water will it contain when 0.7 full?
2. How many inches are there in 0.7 ft.?
3. A coal bunker 24 ft. long, 12 ft. wide and 17.5 ft. high, has running through it a coaling trunk 3 ft. by 2 ft. by 17.5 ft., also a pipe 32 in. outside diameter by 12 ft. long. How many tons of coal will this bunker hold when filled and trimmed evenly to within 6 in. of the top. Allow 42 cu. ft. to the ton.
4. In 43 sec. an engine makes 51 revolutions. How many per minute?

ENGINES AND BOILERS (VALUE 35)

1. Describe the casings, brickwork and baffles of a Babcock & Wilcox boiler.
2. Describe the following: (a) Check valve; (b) internal feed pipe; (c) gage glass fittings; (d) safety valve; (e) surface and bottom blowoffs.
3. Explain how to treat water to prevent corrosion.
4. Assume you have just taken charge of a boiler room in which the boilers are dirty and generally run down as to casings, baffles, and leaky fittings. On last full power test it was reported that the fire room force was not well trained. You were given charge in order that the boilers may be brought up to a high standard, and so to train the fire room force that better results may be obtained on next test, at the end of your overhaul period. Describe in full your method of procedure.
5. Make out explicit directions to water tender for methods of tending water.
6. Give instructions on what to do in case of low water, or water out of sight, in gage glass.
7. Give tube blowing instructions.
8. Describe how to adjust the collars of a turbine engine thrust block.
9. Describe how to cut out the low-pressure cylinder, and compound a triple expansion engine.
10. Describe the forced lubricating system of a dynamo engine.
11. Describe method of lining up an engine.
12. Vacuum is poor; state where to look for trouble.
13. What would you do with a hot bearing without slowing down your engine?
14. Describe the method of adjusting main engine crank brasses.
15. How would you adjust eccentric straps?

AUXILIARIES (VALUE 20)

1. Describe an oil filter and cooler.
2. Show methods of fitting and packing condenser tubes.
3. Discuss the economical use of exhaust steam.
4. Give the name and type of the auxiliary machinery of the last plant in which employed.
5. State where the greatest wear takes place; point out the parts.
6. Where may the greatest trouble be found?
7. Where may trouble be expected?
8. Give reasons; suggest improvements.
9. Describe the testing of: (a) steam gage; (b) vacuum gage.
10. How would you prevent oil and grease getting into the boilers?
11. Describe some type of boiler feed pump.
12. What is a compound gage?

SPARE PARTS AND STORES (VALUE 5)

1. How do you care for spare parts to prevent deterioration?
2. Name the different packings used in your last plant.
3. Make a list of tools required in the engine room for general repair work.
4. Name all firing tools.
5. How can you test engine oil?

MACHINE SHOP PRACTICE (VALUE 15)

1. Should a large engine cylinder be bored vertically or horizontally?
2. Describe the reboring of a large main feed pump, in place; both steam and water cylinders.
3. Name all appliances used on a lathe.
4. How would you lay out and cut a spur gear?

5. How would you straighten a bent piston rod 8 in. in diameter?

6. Name the 3 parts of a foundry flask.

7. How would you prepare the ends of 2 bars of iron for welding? What do you use to make them unite satisfactorily?

8. How would you repair a split in a 10-in. copper exhaust steam pipe?

9. What amount of shrinkage is allowed in pattern making?

10. How many men would you require to rebore a 52-in. engine cylinder?

INDICATOR CARDS AND DRAWING (VALUE 10)

1. Draw a good practical card such as obtained from a cylinder of a triple expansion engine in good condition.

2. Sketch several diagrams showing how different troubles are found by the lines.

3. How do you obtain the indicated horsepower from a card?

4. Explain briefly the essential features of a correct reducing motion for a steam engine indicator.

5. What is the difference between an indicator card from an air compressor cylinder, and one from a steam cylinder?

6. How do you know the correct spring to use when taking cards?

7. Describe what effect wire drawn steam has on an indicator card.

8. Make a longitudinal sketch of a piston rod such as fitted to large engines of 5000 hp. or more.

9. Make a longitudinal sketch of the water end of a boiler feed pump.

10. Sketch a cross-sectional view of a Babcock & Wilcox boiler showing path of the gases and circulation of water.

C. H. WILLEY.

Inverted Slack Belts

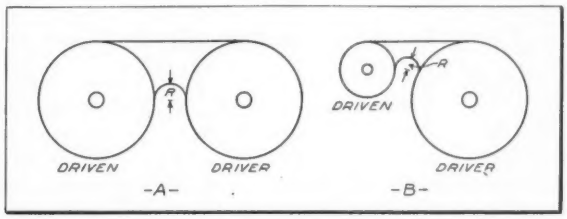
ALTHOUGH I know of no good reason why a slack belt should be run "upside-down" except to be of probable benefit to a drive where the top side is the pulling side, I am nevertheless anxious to have an arrangement such as shown herewith tried out. I am of the belief that after a high enough speed is attained, a slack belt will run upside down as shown both in A and B, and these are my reasons.

It has been found in practice that where a belt runs slack in the ordinary way, the pulling power of the belt increases with speed. The slack belt, rushing against the driven pulley forms a "whirl" that strengthens the contact. This whirl, however, is nothing more or less than another centrifugal force that counterbalances the centrifugal force set up in the driving and driven pulleys. This is proved conclusively in the case of vertical or inclined belts, where, when the pulleys are idle, the belt hangs down out of contact with the lower pulley. In order to start such a drive, an idler is usually used until the drive comes up to speed and then the idler is removed. The centrifugal force in the "whirl" that is formed is great enough to hold the belt in contact thereafter.

Applying this principle, as at A, I therefore argue that where the radius, R, of the slack whirl is small in comparison with the radius of either driving or driven pulley, and where the speed of the belt is high, there will be an upward centrifugal force set up, strong enough to hold the belt in place against the pulleys.

This is true, because the formula for centrifugal force is: $C = \frac{WV^2}{gR}$, where W = weight in pounds of the rotating body; V = velocity in feet per second; g = 32.2; R = radius in feet about which the body is rotating.

This formula makes it plain that the centrifugal force is greater around small radii than about large radii and the latter centrifugal force will therefore be more than counterbalanced.



DIAGRAMS OF INVERTED SLACK BELT DRIVES

At B, I have arranged the pulleys close enough together so that the slack "kink" in the belt will have a considerably smaller radius than the radius of the small pulley. The belt would therefore work—mathematically.

This principle may prove of value, somewhere, in the operation of machines. I should like to see it tried and would like to learn about the results.

N. G. NEAR.

Plugs for Hollow Staybolts

IN THE Feb. 15 issue, J. C. Hawkins criticizes R. E. T.'s answer to questions asked by A. A. H., therefore I hope Mr. Hawkins will allow me a few words of criticism to his answer to the fourth and last question; viz., Why are wooden or asbestos plugs used in hollow staybolts?

Mr. Hawkins claims, among other things, that too much oxygen would make CO instead of CO_2 of the products of combustion. If this is the case, I have been misinformed in regard to the chemical composition of these gases. It has been my understanding, and the limited means at my command, consisting of Orsat, differential draft gage and pyrometer, bear witness to the fact that CO is a combination of 1 atom of carbon with 1 atom of oxygen; while CO_2 is a combination of 1 atom of carbon with 2 atoms of oxygen. Thus we see that CO indicates insufficient air, or oxygen, for complete combustion instead of too much air, as Mr. Hawkins tells us, and while the excess air admitted through the hollow staybolts of the types of boilers referred to in Mr. Hawkins's article does absorb heat that might otherwise be absorbed by the boiler, it does not lessen the completeness of the combustion which has already taken place, but merely cools the gases, overloads the smokestack, and lowers the draft through the grates.

The flue gas would give a lower reading of CO_2 without these holes plugged, as they should always be except when removed for inspection or for blowing of soot from tubes; but instead of a higher CO, he would get a lower CO and a higher O, indicating that both CO_2 and CO were diluted with oxygen at a temperature too low to affect the chemical composition of either the CO or CO_2.

As to the composition of the plug used, I consider an asbestos plug the best, hard wood a good second and an iron plug a poor third. An asbestos plug under ordinary usage will last about a year, and in quantities of 500 can be had at about 7½c each, while the wooden plug will cost less than ½c for labor and may be made of material that would otherwise be scrap, and will last from 3 to 6 months, therefore I use a wooden plug in preference to either the asbestos or iron.

B. M. Babcock.

Pump Trouble; Calculating Boiler Joints

On reading the letter in the Feb. 1 issue, signed R. L., I note that in examining the plungers of his ring and plunger pump, he found about ⅛-in. clearance between the plunger and the sleeve. These pumps have no packing, as the plunger is a neat fit in the ring, and the slippage of water from one end to the other is prevented by this neat fit; ⅛ in. space here will allow a great deal of water to slip through, and will reduce the capacity of the pump in the same manner as a packed piston pump running without any packing. It seems likely, from his statements, that the plunger and ring are badly worn. As the ring has less bearing surface to carry the plunger, it will probably be found worn more than the plunger. In order to regain the capacity of the pump, it will be necessary to take the plungers out and caliper them. If they are not too badly worn, they may be turned down in the lathe. Then a new set of sleeves or rings should be made to fit the plunger, or purchased from the maker of the pump, and these should be a neat sliding fit on the plunger. This will make the pump as good as new. Reducing the size of the plungers will decrease the displacement a little, but not enough to be noticeable.

Some time ago, we had some trouble with a 12 by 8 by 14-in. duplex pump of this type. The pump was used for fire service only, and at that time was only operated about once a month. One morning the assistant was told to limber up the pump, as we expected a fire alarm drill. He opened the throttle, and you may well imagine his surprise when the pump refused to start, nor could it be made to move on one side, and only an inch or two on the other side. The valve gear was disconnected and the valves moved by hand, but with 100 lb. steam pressure at the throttle and the throttle wide open it would not budge.

After putting a pressure gage on the steam chamber, and examining the pump governor to make sure that the pump was getting steam, the water end was opened. In order to do this, it was necessary to drain the water out into buckets to prevent flooding the floor. After the cylinder heads were off the nuts on the studs in the sleeve were taken off, but it could not be taken out. Next, the piston rod nut was taken off; but the rod was a tight fit in the plunger, and could not be removed in the close quarters. The sleeve and plunger could be moved to the end of the stroke, then a piece of 3 by 3-in. hardwood, about a foot long, was cut to fit between the inner end of the plunger and the cylinder head, which space can be reached through the handhole on the side. After getting the block in place, the steam valve gear was disconnected, and operated by hand to admit steam to the inboard end of the cylinder. The cylinder cocks, compression cocks, and valve in the exhaust line were closed, and a little steam turned on by quickly opening and closing the throttle a part of a turn. It took considerable pressure to start the rod, and the steam piston came up hard against the cylinder head, but the cushion prevented it from doing any damage. The plunger and sleeve were removed, and found to be covered with a hard scale about 1/32 in. thick, which was cleaned off with coal oil and emery cloth.

The cause of the scale was that the pump had been standing idle so long that it collected from the water. After the piston was cleaned, the sleeve was found to be a neat sliding fit. In reassembling the pump, the plunger was given a coating of cylinder oil and graphite, the idea being to provide lubrication for a time at least, and to prevent scale from sticking to the plunger. Orders were also given to run this pump ½ hr. at least twice a week. The other plunger was also covered with scale and was taken off in the same manner, although it came off easily. The sleeve of the second plunger was taken off by placing 2 short blocks between the sleeve and the partition on each side of the plunger, and pulling the plunger out of it by steam pressure.

The question of frictional resistance between the plates in a riveted joint as brought up by Mr. Marier is not new, but it is of so little importance on the side of safety that it may well be ignored.

The safe working pressure as figured from the Massachusetts rule may not agree very closely with the actual safe pressure which could be allowed on the boiler, nor the actual pressure at which it would burst if tested to destruction.

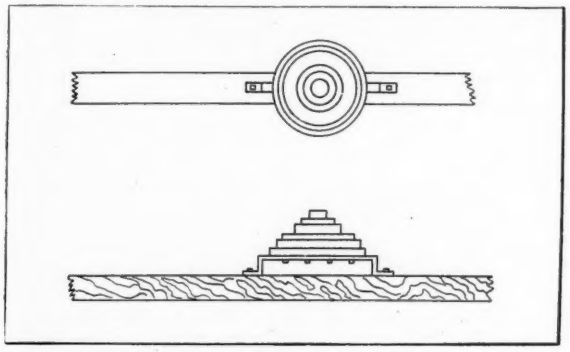
Introducing the calculations of the frictional resistance of the joint into the problem would make it no more complete, and at the same time would require more calculation, and give more chance of errors. There is also another good reason why the frictional resistance may be ignored, and that is that in the approved Massachusetts joint, which is a butt and double strap construction, in nearly every case of a well designed joint the weakest point, or the point at which it is most likely to fail, is by tearing the plate between the outer row of rivets. In this case, the frictional resistance would have no effect on the calculations.

There are so many other things which must be taken for granted in assuming the theoretical efficiency of a boiler joint that the matter of frictional resistance, which makes for additional safety, may be left out. If the bursting strength of the boiler as figured from the accepted rules comes within 10 to 50 lb. of the actual pressure required when the boiler is tested to destruction, it will be by chance rather than from accuracy of the figures used in the problem. J. C. Hawkins.

Templet for Cutting and Fitting Packing

WHILE EMPLOYED as machinist in the power plant of a local establishment, the writer had a great amount of rod packing work to do, as the concern had a number of pumps in continual operation. In addition to this, the pumps were invariably hot when a set of packing needed attention or removal, and were the cause of many burned wrists, as the packing was necessarily cut and fitted carefully to the rods.

A wooden block was turned, on which were finished the sizes of all the piston rods and cylinders about the



PACKING TEMPLET

plant, taking the styles of packing which necessarily had to be cut and fitted before application. The various sizes were marked for the particular pumps, etc., and when the engineer reported any particular piston, all the writer had to do was to cut the stock off and fit it by the templet which was located conveniently over the work bench. The rings then being perfect in size, were quickly shoved into place with a packing hook.

For a safety device, as well as an arrangement for saving time, the above-mentioned is excellent.

F. W. BENTLEY.

Belt Slip and Power Loss

I HAVE been asked to write in crisp, concise language, my views on the relation between belt slip and power loss where slip is constant and where slip is variable, and I wrote the following:

Constant Slip: Where slip is constant and where both driving and driven pulleys run at uniform speeds, the per cent of power loss is exactly equal to the per cent of slip. This is true because the tensions on the slack side and tight side are constant. The belt serves, partially, as a Prony brake. Maintain the same tensions and stop the driven pulley and the belt slip will be 100 per cent. The power loss will therefore be 100 per cent.

Irregular Slip: Where slip is irregular much depends upon the duration of the slip period. If the slip is just momentary it is reasonable to assume that there is practically no change in belt tensions, and the per cent of power loss will be just a little less than, but practically equal to, the per cent of slip.

Where the duration of slip is great, it is certain that there is a change in tensions for the driven pulley usually slows down. The engine's tendency to race is checked by action of the governor, which admits less steam into the cylinder. The per cent of power loss here might be considerably less than the per cent of slip. Such extreme slip, however, seldom occurs in practice.

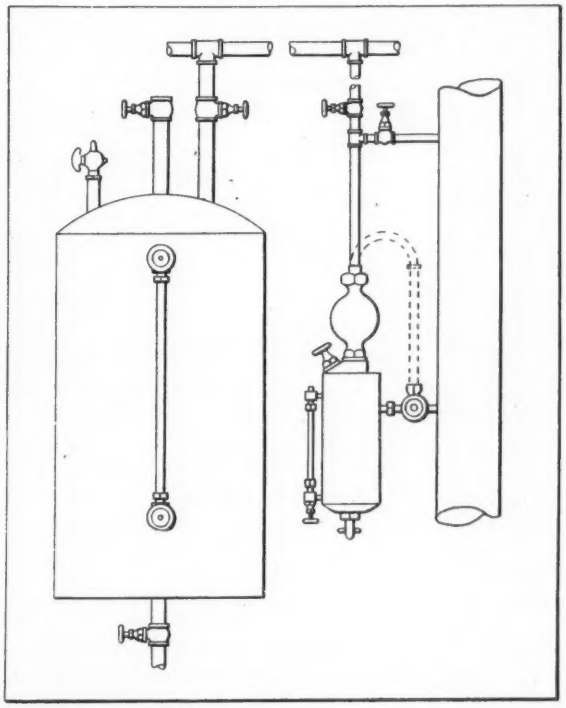
On gas engine pulleys, where slip occurs during the explosion stroke, the per cent of power loss is greater than the per cent of slip because the slip occurs when the tension difference in the belt is at its maximum.

In any case, the horsepower loss due to belt slip is: (computed speed of belt running without slip, in ft. per min. — actual speed of belt, in feet per min.) × difference in belt tensions, pounds ÷ 33,000 = horsepower.

N. G. NEAR.

Oil Reservoir for Cylinder Lubricators

HEREWITH is an illustration of an oil reservoir for supplying the oil to cylinder lubricators throughout a plant. The connections are as indicated in the illustra-



CONNECTIONS TO CYLINDER OIL RESERVOIR

tion, and the arrangement has been found extremely satisfactory, and has resulted in a great saving in oil.

THOMAS A. HAWTHORNE.

A NEW STEEL, claimed to be non-rusting and untarnishable, and called Tirth's stainless steel, has been introduced by a Sheffield, England, firm, according to United States Consul John M. Savage, of that city, in Commerce Reports. The new metal is especially adapted for table cutlery and requires only ordinary washing to clean it. It is said to retain a keen edge resembling that of double-shear steel, also that the properties are inherent and not due to any treatment. The price is reported to be 26c. per lb., or double that of the usual steel for the same purpose. It also costs more to work up.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

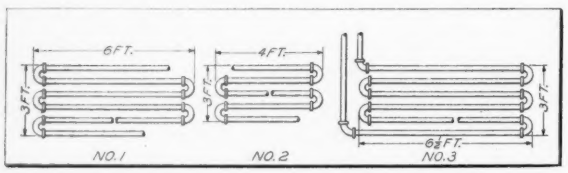
Refrigeration Trouble

WE HAVE a 2-ton ice tank located about 70 ft. from a small cold storage room cooled by brine pumped from this tank. The connecting pipes are underground and are uninsulated. In wet or damp weather, we are unable to keep the room cool, and a continuous stream of warm brine runs back into the ice tank.

The coils, shown in the accompanying figure, are made up of 1-in. pipe. Coil No. 1 is placed on the left side of the room, No. 2 on the back end, while No. 3 is placed in a bunker on the right side.

Will I gain anything by cooling by direct expansion with the expansion valve in the storage room?

Can I use a ¼-in. pipe to carry the liquid over and a ¾-in. pipe as a return? G. R.



PRESENT ARRANGEMENT AND SIZE OF COILS

A. The installing of a direct expansion system for cooling the cold storage room would necessitate the continuous operation of the ice machine, or the temperature would vary greatly. In a small plant, even when a small amount of ice is made, the compressor is usually shut down during at least part of the night, and the brine pump kept going for holding the temperature of the rooms and ice vault. Even if the compressor is run all the time, there is always the liability of a breakdown, and when this occurs, and the cold storage is piped for direct expansion, the refrigeration stops when the machine stops. With brine circulation, the cold storage can be held at a safe temperature for several hours after the machine is stopped.

If direct expansion is desired, it is best to use new pipe instead of the old brine coils, as they will be hard to clean of scale, dirt and moisture. Make one coil covering the 3 walls. The 3 small coils now in use are so short that it would be found difficult to regulate the ammonia, and the brine coils would have to be all taken down and the joints made up with litharge and glycerin. New pipe and fittings will be found the best. Use a ½-in. liquid line and 1-in. suction and run them close together, and cover them in one covering of either cork or hair felt. The liquid can be admitted either at the top or bottom of the coil, as the results are about the same with proper handling.

For a small cold storage room, the brine circulating system is best. As I do not know the size of the room, or the temperature at which it is held, or the amount of produce handled, I cannot tell whether the amount of coil surface is sufficient.

The brine lines from the pump to the room and back to the ice tank should be taken out of the ground, if possible, and run overhead or along the wall. They should be covered with the best insulating material available. The insulation will pay for itself in a season. If it is not possible to run these lines except under ground, they should be covered with moisture-proof insulation and a box built around them. Hemlock planks make a good box which will last for years.

A. G. SOLOMON.

Boiler and Engine Questions

UNDER WHAT condition can a short stack or chimney be used successfully?

2. Why is the common slide valve not used on large engines, and high steam pressure?

3. Is the thrust pressure, due to the angularity of the connecting rod, greater on a vertical, than on a horizontal engine? Why? Does the length of the connecting rod have any effect on it? Why?

4. Under what conditions could a pump be placed 30 ft. above the water supply and made to work?

5. If your safety valve was set to blow at 200 lb. and the inspector ordered it set at 160 lb., and after making the change you get a 10-lb. blowback, how would you remedy it?

6. Why is the seat of a safety valve beveled to an angle of 45 deg.?

7. Why is it safe to expose the upper part of the tubes of a vertical tube boiler to the fire and hot gases, while in a horizontal tubular boiler the upper rows of tubes must be covered with water?

8. Why does the pressure on the surface of water affect the boiling point of the water?

9. What changes can be made in the pipe connections from pump to boiler to stop vibration and pounding?

10. How could you use an injector in conjunction with a feed water heater in feeding a boiler?

11. If a plain slide valve engine has ¼-in. lap, and you turn the eccentric halfway around on the shaft, will it reverse the motion of the engine?

E. S. L.

A. The only way that a short stack or chimney can be used successfully is to install a system of mechanical draft to produce the required draft for perfect combustion.

2. The common slide valve is not used on large engines, because its size would make it unwieldy, and it is not as economical of steam as some other types, also the friction of a large unbalanced valve is greater than it should be. With high pressure steam the unbalanced valve sets up a great amount of friction.

3. The difference in thrust pressure due to angularity of the connecting rod between a horizontal and vertical engine is so slight that the slide-bars are designed for the same pressure, the usual rule being: Maximum pressure on slide bar equals pressure on piston times crank radius divided by the length of connecting rod.

This rule shows that the pressure on the slide bar varies inversely as the length of the connecting rod. The reason for this is that the longer the connecting rod, the more nearly is the pressure upon the piston transmitted in a straight line to the crankpin so that less pressure is needed to keep the piston rod in line with the cylinder.

4. The height a pump should lift cold water with a perfect vacuum is 34 ft.; but, since a perfect vacuum cannot be obtained on account of valve leakage, air in the water, etc., the actual height is generally less than 30 ft.; the conditions are, therefore, cold water and perfectly tight valves and piston.

5. The only way to remedy a blowback of 10 lb., would be by regulating the blowback mechanism. This would depend on the make of the valve you have. Most safety valves have what is called a "blowback ring," and by readjusting this ring, the correct blowback is obtained.

6. The Massachusetts Board of Boiler Rules says that the seat of all safety valves should be inclined at an angle of about 45 deg. This was probably chosen as standard after various tests proved it to be the most satisfactory angle.

7. The reason it is safe to expose the tubes above the water line in a vertical tubular boiler to the fire and hot gases, is that the water absorbs most of the heat passing through the tubes so that by the time the hot gases reach the water line, they are sufficiently cooled to cause no serious damage to the tubes. The part of the tubes above the water level in a vertical boiler is, in reality, superheating space. In a horizontal tubular boiler, all the tubes receive the gases at the same temperature, and must, therefore, be surrounded by water to keep them from becoming red hot, the water level being above the upper row of tubes.

8. This is one of the laws of nature and may be explained by stating that mechanical work has an equivalent in heat so that when a pressure is put upon the surface of water, an equivalent of that pressure in heat must be used in order to boil the water; i.e., to overcome the pressure upon the surface of the water.

9. If the discharge line from pump to boiler vibrates, it can be anchored, if the vibration is due to long, limber sections of piping, or an air chamber can be attached to the discharge near the outlet of the pump.

10. An injector can handle cold water only, so that in order to use it with a feed water heater, a closed heater must be used and the injector used to feed the heater, which discharges direct to the boiler.

11. Yes, turning the eccentric halfway around will reverse the engine, but all events of the cycle will be exceedingly late; there will be no compression, admission will take place considerably after the crank has passed center, and cutoff will take place nearly where release should be, making a badly distorted card.

To reverse an engine, the proper method is to place the eccentric as far behind the crank as it was in front, the eccentric will then lead the crank in its new direction of motion by the same angle it formerly did.

G. A. T.

Boiler Metal Treatment

ARE YOU familiar with boiler metal treatment? Is it all right to use?

A. Owing to the vast difference in the waters at different places in the country, and even in the water at the same place at different seasons of the year, it stands to reason that a water softening mixture or scale preventive, is handicapped to a greater or less extent by this difference. Realizing this, chemists, for the most part in Germany, have brought out after a number of years experimenting in actual practice, a compound which does not act on the water at all. In fact, it is immaterial what the chemical analysis of the water might show, at different localities, or at different seasons of the year in any one place, for the compound you mention, and some others also, along the same line, ignore the water and go right to the metal, for which they have a strong affinity.

Once in contact with the boiler shell and tubes, they form a heat conducting and scale resisting coating which prevents the formation of scale, and not having a chance to obtain a foothold, so to speak, the boiler can at all times be kept free from scale.

The writer is familiar with several instances where this compound has been used with great success.

G. H. WALLACE.

Wattmeter Calculations

PLEASE GIVE me the formula or constant for finding the total kilowatt output of a 3-phase generator by timing the disk rotations of a 2300-v. Westinghouse polyphase integrating wattmeter; also the method of finding the disk constant of various size meters. C. D.

A. All Westinghouse meters run 25 r.p.m. with full load passing through them. Full load in the case of a polyphase meter would mean twice the product of the current and voltage capacities marked on the meter. For the last 2 or 3 yr. these meters have had a small paster on the inside of the terminal cover which gave the kilowatt-hours per revolution of the main disk.

You can obtain the kilowatt-hours per revolution from the above data or from the marking on the paster in case the meter was originally supplied with this information. Knowing the kilowatt-hours per revolution, you can readily determine the kilowatts flowing at any given time by counting the revolutions for a short period, and making the proper calculation.

WESTINGHOUSE ELECTRIC & MFG. CO., WM. BRADSHAW.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Care of Boilers

I HAVE charge of a battery of 2 new boilers, one in use, the other in reserve.

As I would like to care for these boilers in a proper manner, I wish some of the readers would tell me what, in their opinion, would be the best height at which to keep the water in the reserve boiler so as to prevent pitting and corrosion. The water used is very good, as it contains little scale forming material. F. O. B.

Heating System Difficulty

IN THE Feb. 1 issue, problems for discussion by readers, R. L. says he changed the steam end of his pump to right the slam.

According to my theory, I would examine the water valves and note whether any of these are not O.K. If a pump runs smoothly for 3 strokes of the pump and jerks back on the fourth, it nearly always indicates a defective valve in the water end; but there is no way of telling

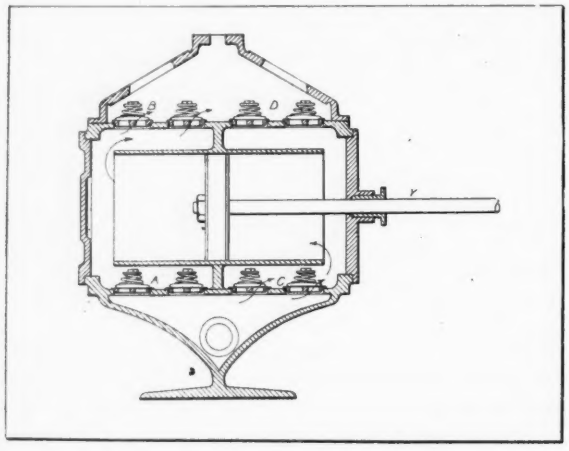


DIAGRAM SHOWING PUMP ACTION

whether it is a discharge valve in the end which the plunger is leaving, or a suction valve in the end which it is approaching, except to remove the handhole plates and examine the valves until the one is found which is causing the trouble.

Referring to the illustration, it is evident that if the suction valve A is broken, or if the entire valve seat is knocked out of the valve deck, as sometimes happens, the water, instead of being forced through the discharge valves B, against the pressure, will simply surge back through the suction valve A and flow into the cylinder through suction valve C, thereby relieving the piston of practically all resistance and causing it to jerk back suddenly to the head end. Similarly, if discharge valve D is broken, when the piston moves towards the yoke Y, it forces the water into the force chamber against the pressure; but when it returns towards the head end, valve D fails to hold the water, and it surges around from B through D into the cylinder, relieving the piston of resistance, the same as in the case of the broken suction valve.

It is, therefore, evident that a sudden stroke toward the head end is caused either by a defective suction valve in the head end or by a defective discharge valve in the yoke end, and *vice versa,* a sudden stroke toward the yoke end indicates a defective suction valve in the yoke end or a defective discharge in the head end. The degree of suddenness or freedom with which the stroke occurs evidently depends upon the extent of the leak.

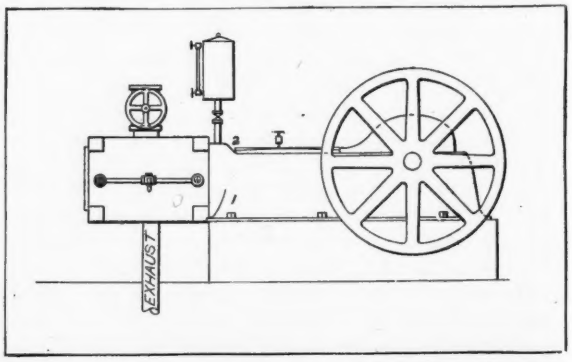
Frequently, a small hole in a valve does not allow enough water to pass to cause any perceptible irregularity in the action of the comparatively large pump, and it can be detected by the noise of the water surging through it, and should be remedied as quickly as possible. Should a serious defect of this kind exist when the pump is started, it will usually fail to create a vacuum in the suction and to pick up its water.

G. H. SMITH.

Indicator Trouble

AS A remedy for L. F. B.'s indicator trouble as outlined in the Feb. 15 issue, I submit the following:

At a small expense get 2 small iron pulleys with swivel joints; drill and tap a small hole on the side of



SIDE ELEVATION OF BALLWOOD ENGINE SHOWING PROPER LOCATION OF BRACKETS AND SWIVEL PULLEYS

the engine bed at 1, in the accompanying illustration, and secure a bracket with pulley attached so as to be in proper alinement with the indicator.

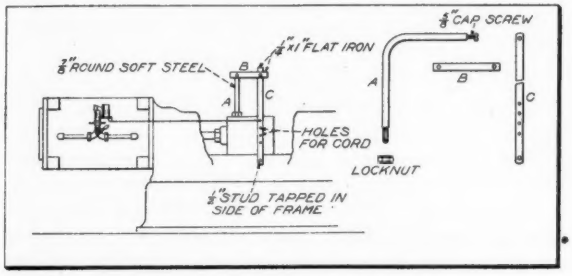
In a like manner attach another bracket and pulley at point 2, taking care to have this lined up with the crosshead connection and with the first pulley. Locate

the second pulley as low as possible but avoid having that length of cord between the 2 pulleys come in contact with the frame of the engine.

Wooden brackets, if properly stayed, will answer the purpose. SUBSCRIBER.

THE FOLLOWING, I believe, will help L. F. B. solve his indicator mechanism trouble. In the accompanying illustration is an arrangement that I am sure will work successfully; in fact, I believe it to be the only thing he can use on his type of engine frame.

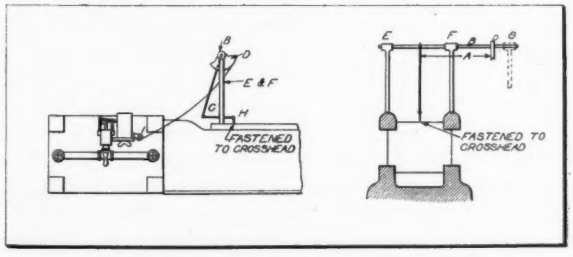
Having secured the 3 pieces marked A, B and C, tapped, drilled and provided with set screw and lock nut as shown, drill and tap the crosshead and insert



INDICATOR REDUCING MOTION

piece A, locking it by means of the nut provided for that purpose. A should be so placed that when C is at the center of the crosshead and in a vertical position, link B will have a length of at least 4 in. C is then bolted to B and to the side of the frame as shown so as to be in a vertical position when the crosshead is in mid-stroke. The length of the horizontal part of A is determined by the distance between the center of the engine and the indicator cord. A. SUBSCRIBER.

THE ACCOMPANYING illustration may help L. F. B. A small shaft, about ¾ in. in diameter, is placed as shown and held in place either by the 2 bearings E and F or by the single bearing G if a proper support is available. These bearings should, however, be well fitted to avoid lost motion.



INDICATOR REDUCING MOTION AS SUGGESTED BY H. D. EVERETT

Pulley D placed on shaft B so as to be in direct line with the indicator mechanism is driven by motion transmitted from the crosshead through link H to pendulum C. As the crosshead travels back and forth, the indicator cord, attached to pulley D operates the drum of the indicator.

If possible, a ¾-in. shaft should be used at B, although a 1-in. shaft may be more satisfactory.

HARRY D. EVERETT.

Reply to Engine Questions

IN ANSWER to the questions of F. V. B., on page 282 of the March 1 issue, I submit the following:

1. There is no reason why a tandem compound engine cannot have 4 eccentrics. Two are, however, all that are necessary, since the gearing which operates the steam valves on 1 cylinder is connected through rocker arms and hook rods so as to operate the same valves on the other cylinder. The same is true in regard to the exhaust valves. The addition of 2 more eccentrics would, therefore, add complications and increase the first cost of the engine.

2. A well-built engine properly erected on a good foundation will, with intelligent care, operate for years without getting out of line to any serious extent.

The spherical pins would be an unnecessary extra first cost and no material advantage would be gained, to say nothing of the special work necessary to use them.

3. The stresses to which the pins of an engine are subjected are severe and a ball bearing, to carry such loads safely, would be unduly cumbersome and add much to the first cost of the engine.

Again, one of the primary requirements of any good bearing is that it has simple and positive means of securing exact adjustment and it is advisable to make the adjustments of main bearing while the engine is running so as to enable one to feel the adjustment. This cannot be done with a ball bearing.

Another objectionable feature is that the several parts would not be interchangeable for engines of the same make and size, and additional work and expense would be brought into account when renewals became necessary. RECEIVER.

Leakage Through Tunnel Walls

IN REGARD to the inquiry of J. C. H., in the March 1 issue, under the above caption, I wish to say that I have not had any experience under those conditions, but I have learned from good authority a process that may be of some benefit to him in overcoming his difficulty. Sodium silicate, commercially known as water glass, is often used in making concrete tanks impervious and sanitary.

The surface of the walls and ceiling should be made as smooth as possible by chipping off any projection made by the joints between the boards. Then, to remove the dirt and dust, wash the surface with clear water. This should be done during the dry season, so the walls will dry before applying the water glass. To one part of water glass add 5 parts of water. Apply the solution with a brush, and after 4 to 6 hr. give it another coat. If the tunnel is dusty the surface should be washed off and allowed to dry before applying another coat. Repeat the process with 4 coats, not allowing the time between applications to exceed 24 hr. It is said the surface forms into a hard and insoluble scale.

LAURENCE KJERULFF.

WHENEVER YOU do a hard job Nature compensates you by making you stronger and more able to accomplish a more difficult task. In order to advance, then, Nature would have you constantly working at the limit of your ability.

PRACTICAL
ENGINEER

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The Summer Load

As facts and records show beyond a doubt that the well kept modern isolated power plant which supplies heat to buildings requiring all the exhaust steam is more economical than central station power, central stations are soliciting owners for the summer load. Several seasons have passed since this practice was put into operation by many central stations, and we are now able to see the results more clearly and to determine more closely in what plants central station power really is more economical than that which can be generated in the isolated plant.

As engineer employed by the owner of the plant, it may probably fall to your lot to solve this problem when your plant has been solicited. Even though it may seem hazardous to let the central station furnish you with power, in some cases it will put money into the owner's pocket and, in the long run his interests are yours.

On the other hand, many power plant owners would make a serious mistake if they allowed the central station to install a switchboard and other necessary equipment for supplying the plant with power.

The solicitor is working for the central station's interest. Every argument that he can advance in favor of his product will be presented; he naturally sees but one side. The engineer should present facts as he finds them, whether they are in favor of central station power or against it.

Presuming that an isolated plant is provided with a complete system of records showing unit costs for a number of years back and central station power is offered at a price below the unit cost shown in previous years, giving an apparent advantage in buying power, there are other things to be considered. Have you a well trained boiler room crew, also efficient watch engineers? What will become of them? Can you afford to let them go, and break in new men in the fall? Very likely your power during the winter would cost considerably more than it has for some time, for there are few good men who care to take a temporary position.

Then, too, interest and depreciation charges must be added to the central station cost, as neither of these stop when you buy power but part of the year. In some plants it will even be necessary to add to the equipment in order to use electric drives and interest and depreciation on this for the entire year must be charged against the power bought during the summer, as must also the services of the men necessary to keep the plant in operation during this period.

There is an advantage in having central station power to fall back on in case of a shutdown during winter, but the cost of throwing the switch is usually made so high in the contract that all the saving that may be made in the summer is offset by the use of central station power but once or twice in winter.

There is no question but that this move of the central stations will result in economy in some plants, but there are so many angles to be viewed that only close study and complete records can prove what plants will be benefited. The season, however, is almost here and you should be ready to answer all questions and meet the situation as it arises.

Complainers

"I made an awful mistake in taking up this kind of work," is as well known a saying among power plant men as it is in all other trades and professions with which we come in contact. Doctors, lawyers, actors, and even ministers of the gospel make bitter complaints about their lot.

To hear anybody complain about hard luck, though, is usually a bad sign; the cause of the hard luck can almost invariably be traced squarely back to the complainant himself. We don't hear the "best men" complain, because they haven't time for such things; they are too busy progressing and keeping above those who have time for foolish mutterings.

The owner of a power plant made this remark recently: "The next time I employ an engineer, I certainly will not select one who is 'sick of his job.' I want one who is alive every minute and who loves his work as much as his religion. If he has no religion, I want him to love his work as much as he loves his mother, wife, or sweetheart. If he doesn't love anything, he is hopeless and I would not even consider him."

To complain is to acknowledge that you are weak—that you are not the best in your line, nor even successful. And every time you air your weaknesses you grow weaker.

We do not mean that an engineer should bluff and pretend that he is more than he is. It is permissible to admit that you are unacquainted with a detail here and a detail there, but don't keep on admitting it forever, thus advertising your weakness. Study the detail until you *understand* it. By thus plodding along, keeping yourself interested in your work, studying, progressing, you will soon find yourself out of the "admitting and complaining class" and you will find many opportunities ahead.

Ever hear of a man who worked hard and who concentrated his mind upon his work, who did not progress? We never have. Such men do not complain.

The non-complaining man is the man who generally gets the most energy out of a pound of coal. He is a natural economizer. To waste time, money, and words would be painful to him.

News Notes

PROFESSOR G. A. GOODENOUGH, of the Department of Mechanical Engineering of the University of Illinois, recently gave a lecture on "The Development of the Steam Turbine" before the College of Engineering of the University of Wisconsin.

HARRY J. ERNST, advertising manager of The D. T. Williams Valve Co., has been elected Treasurer to succeed R. E. Mullane, who was recently elected President of the company.

U. S. CIVIL SERVICE COMMISSION announces an examination for electrical draftsman (radio), on April 7 and 8, 1915, to fill a vacancy in this position at an entrance salary of $4 a day, in the Navy Yard, New York, N. Y. The duties of this position require the origination and design of apparatus, switchboards, machines, and appliances used in radio communication, plans of their installation, writing up of specifications for apparatus, material, estimating, checking plans, etc.; writing up descriptions, instructions for use, care, and maintenance of the apparatus indicated. Persons who desire this examination should at once apply for Form 1312, stating the title of the examination for which the form is desired, to the U. S. Civil Service Commission, Washington, D. C. The title, Electrical Draftsman, Radio (Male), should be stated in the application form.

U. S. CIVIL SERVICE COMMISSION announces an examination for subinspector, on April 7, 1915, to fill a vacancy in this position at $4.48 a day in the Navy Yard, Washington, D. C. Competitors will be examined in practical questions in engineering construction and estimates of materials, and training and experience. Applicants should be men of good practical experience in one of the building trades who have served at least one year as foreman on some piece of work, such as wharf building, foundation work, concrete work, brickwork, structural-steel work, or carpentry work. Applicants should have a fair common-school education and be capable of reading drawings, making measurements of work, and calculating quantities of materials in place. Applicants who lack experience in the trades, but who have had two years or more of technical training and one year's experience in the inspection or handling of some construction work, will be permitted to enter the examination. Apply for Form 1312, stating the title, Subinspector (Male), to U. S. Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE COMMISSION announces an examination for assistant inspector of engineering material, on April 7, 1915, to fill a vacancy in this position in the Office of Inspector of Engineering Material at Pittsburgh, Pa., at a salary of $4.48 a day. Duties will consist in the inspection to require contractors to carry out plans and specifications prepared by the Navy Department for machinery and engineering appliances, and to pass upon tests of such apparatus and materials used in connection with miscellaneous engineering work for the United States Navy. To be eligible, applicants must be able to understand drawing, specifications, schedules, and orders for engineering material, to conduct shop tests and make necessary calculations connected therewith, and be capable of writing reports with recommendations covering the inspections and tests made, especially as to all types of unfinished and finished metal materials, machine tools, instruments, and auxiliary machinery supplied to the Navy Department. Applicants must have had at least 3 yr. practical experience in mechanical engineering, preferably as acquired in the testing departments of bureaus, engineering works, or manufacturing concerns, or in the laboratories of technical schools. Persons who desire this examination should at once apply for Form 1312, stating the title, Assistant Inspector of Engineering Material (Male), to the U. S. Civil Service Commission, Washington, D. C.

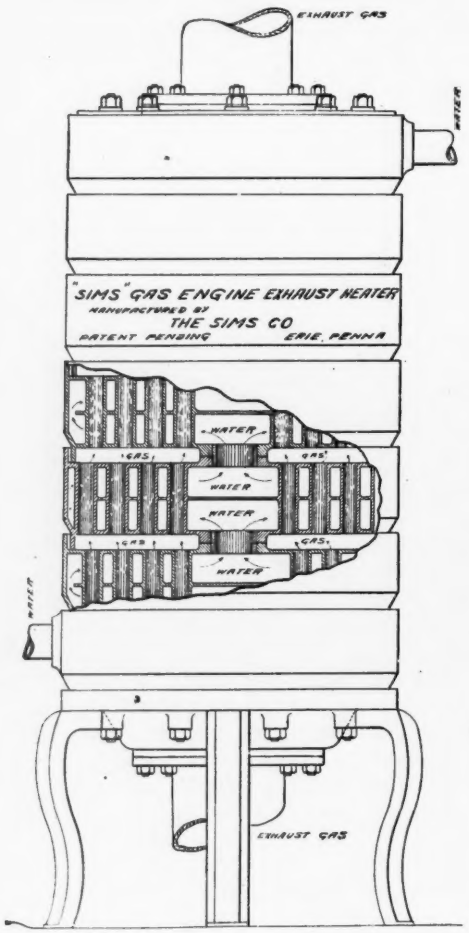
"NATIONAL" BULLETIN No. 24, discussing relative production of wrought iron and steel pipe since the introduction of steel pipe, in 1887, was lately issued by National Tube Co., Pittsburgh, Pa.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Gas Engine Economizer

AFTER many attempts to utilize properly the heat of waste gases of internal combustion engines, The Sims Co., Erie, Pa., has brought out the "Sims" gas engine economizer, claimed to stand the required service and produce satisfactory results.



"SIMS" GAS ENGINE ECONOMIZER

This economizer or heater is constructed of round cast-iron sections built up in number and size according to the horsepower of the engine in service. As shown in the accompanying illustration, all sections are properly faced, giving a metal to metal joint, and are supported and joined by means of screw-threaded sleeves, resulting in a uniform expansion and contraction of each. Each section is provided with a flange or circumferential groove forming a keystone shaped orifice into which is calked suitable packing material.

When 2 or more sections are used, the exhaust gas passages are staggered, bringing the hot gases in contact with the greatest possible amount of heating surface. Water spaces completely surround the walls of the gas passages the connection from one section to another being through the above-mentioned sleeves.

Not only is it possible to heat water and generate steam up to a pressure of 20 lb., but by an ingenious arrangement of water connections of the different sections, it is possible to work out a variety of combinations, such as heating water at different temperatures and at the same time generating steam. In addition, it is stated that with no practical use for the heated water and steam, the installation of this heater will be found economical in gas consumed, power developed and better operating conditions for the engine.

Rochester, N. Y., Water Power Plant

A HYDRO-ELECTRIC generating station which is unique as regards its low cost per kv.a., has recently been put in operation by the Rochester Railway & Light Co. The total cost of the station, the capacity of which is 4500 kv.a., was $176,000, making a cost per kv.a. of $39.10. It is interesting to compare this figure with the average value of $125 per kilowatt given by Messrs. Stott, Pigott and Gorsuck in the June, 1914, A.I.E.E. Proceedings.

The total cost included the preliminary investigation, reports, cost of building, intake and forebay construction, head works, penstock, tail race, and 3000 ft. of underground lead cable for tying this plant to 2 other generating stations, as well as the initial and installation costs of the hydraulic and electrical apparatus. This figure, however, does not include any items covering water rights or real estate.

During the 8 months since the plant was put in service on March 15, 1914, it has generated 12,000,000 kilowatt-hours, operating at a load factor of approximately 46 per cent. It will be possible to increase the output considerably during the winter months on account of the larger amount of water available.

Figure 1 shows the exterior of the station situated on the Genesee River in the heart of the city. The building is a one-story structure of reinforced concrete, inside dimensions 38 by 96 ft. The generating equipment consists of 2 units, one a 3000-kv.a., Westinghouse waterwheel generator, 11,000-v., 3-phase, 25-cycle, direct-con-

nected to a 5000-hp. Wellman-Seaver-Morgan horizontal turbine; the second, a 1500-kv.a. Westinghouse waterwheel generator of the same voltage and frequency, direct-connected to a 2500-hp. horizontal turbine furnished by the Camden Waterwheel Works.

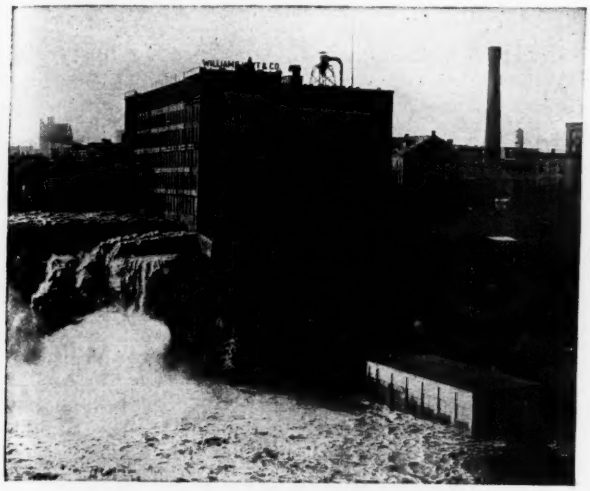


FIG. 1. A 4500 KV.A. WATER POWER PLANT, ROCHESTER RAILWAY & LIGHT CO. PLANT AT EXTREME RIGHT; FLOOD TIME

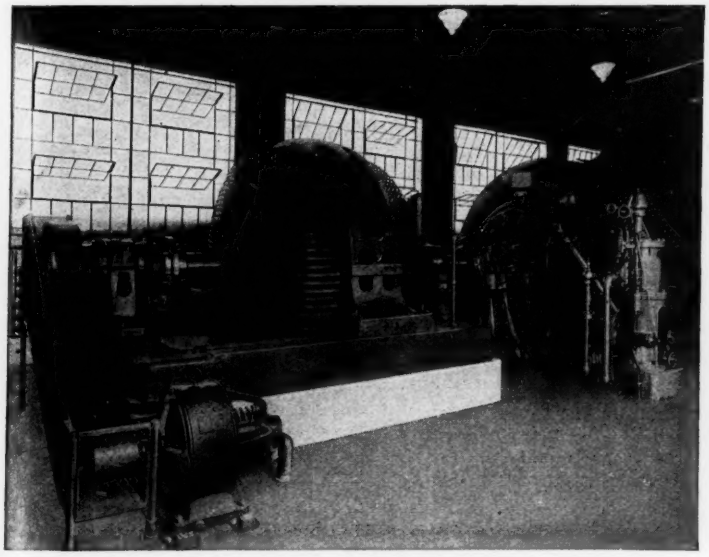


FIG. 2. A 3000-KV.A. WESTINGHOUSE WATERWHEEL GENERATOR, 11,000-V., 3-PHASE, 25-CYCLE, WITH EXCITER

Figure 2 gives a view of the interior, showing the 3000-kv.a., unit.

The new station furnishes part of the power for operating the local street railways, and also handles some of the industrial and lighting load in Rochester and vicinity. It is operated in parallel with a 15,000-kv.a., 25-cycle steam plant and the hydraulic plant of the Niagara, Lockport and Ontario Power Co. at Niagara Falls, 100 miles distant, which supplies current to the Rochester Company at 60,000 v.

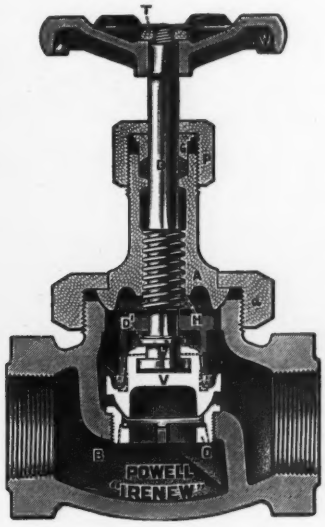
Powell Irenew Valve

IN many places about a power plant, an iron body valve is preferable for mechanical reasons and to fill this need the Wm. Powell Co. of Cincinnati has developed what is called the Irenew valve, which has an iron body with bronze mounting.

Referring to the illustration, the valve stem, D, has machined Acme threads which screw into the bonnet, A, the latter being provided with a cone of beveled face connection similar to a ground joint and held to the body of the valve by means of a hexagonal swivel nut, a. On the stem is a collar, D^1, which fits against the recess, H, in the bonnet, allowing repacking of the valve while wide open and under pressure.

The disc is of the renewable horse shoe type, made of white Powellium bronze and arranged to slide over the head of the stem into a socket, permitting it to swivel freely. To remove the disc it is only necessary to slide it from the socket. The seat ring, O, is also cast of white Powellium bronze and may be removed by means of a flat tool of any kind engaging the lugs projecting from the inner circle.

To regrind the disc and seat ring release the bonnet, A, withdraw the valve trimming, insert a pin of suitable size in hole, L, to lock the disc, then apply the grinding mixture to the disc and rotate it back and forth on the seat ring until a good bearing is had. The valve is then cleaned and assembled, the work having been done without removing the valve from the line.



SECTIONAL VIEW OF THE IRENEW VALVE

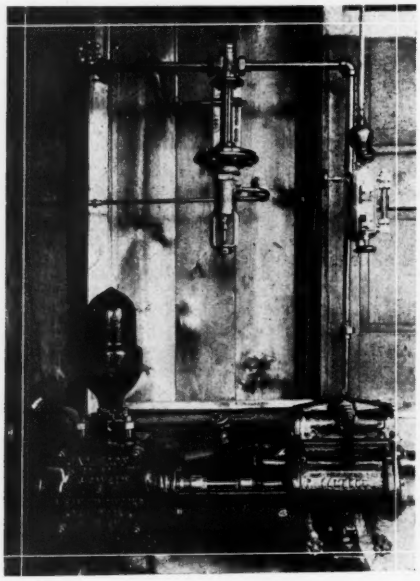
These valves are made in sizes from ¼ in. to 2 in., and are proportioned for 150 lb. working steam pressure.

THE ADVENTURES of a Bale of Hemp are related in story form, based on the voyage of the British steamship Bloemfontein, which left the Philippines 2 days before war was declared. On board was a large consignment of manila hemp for the Columbia Rope Co., of Auburn, N. Y.

Regulating Boiler Feed Pump

ILLUSTRATION herewith and the description took 5th place in the photographic contest of the Mason Regulator Co. and shows an interesting method of controlling boiler feed from a general service pump. It was sent by A. H. Cutler, engineer of the Eureka Silk Mfg. Co., Putnam, Conn.

"This ¾-in. excess pressure feed line regulator was installed about 2 yr. ago, to control boiler feed from a pump supplying hot water for boiler and also to several sinks and vats in the mill.



METHOD OF CONTROLLING BOILER FEED FROM GENERAL SERVICE PUMP

"Before it was installed, the pump was controlled by throttle, and it was very hard work to keep a uniform water line in the boiler, as when water was used in the mill, the pump would run faster while delivering water at a lower pressure.

"Now, with this regulator, we open the throttle valve wide, keep an excess pressure of 10 lb. above boiler pressure and control the feed to boiler with a valve in the feed line. I never touch the throttle valve in feed line from Monday morning to Saturday noon, when I close it at the end of the week's run.

"The watchman starts the pump early in the morning, and it is not stopped until he stops it after the boiler has been filled for the night and fires banked."

Book Review

DRAKE'S TELEPHONE HANDBOOK. By David Penn Moreton, Chicago, 1915; 286 pages, 161 illustrations. Price, $1.

To all interested in the telephone and its application, this book ought to prove of value.

In preparing this volume, the author has evidently assumed that the reader is unfamiliar with the elements of electricity and magnetism, as in the first 5 chapters particular stress has been laid on the subjects of electrical circuits, electrical units, magnetism, electromagnetism, electromagnetic induction, batteries, the alternating-current circuit, inductance, capacity, the measurement of resistance and capacity and the location of faults in circuits.

Chapter 6 is on sound. Since the primary purpose of the telephone is the transmission of sound, the author considers it essential that the reader understand its fundamental qualities in order to appreciate the problem the telephone engineer is called upon to solve in the propagation of sound by means of the telephone.

Chapters 7 and 8 deal with the magneto and common-battery systems respectively.

Chapter 9 deals with practical line construction and contains numerous valuable tables bearing on this work.

Telephone troubles and methods of locating and repairing them and telephone inspection are subjects well treated in Chapter 10.

HAND FIRING SOFT COAL UNDER POWER PLANT BOILERS, is the title of Technical Paper 80, just issued by the United States Bureau of Mines, as an aid to the firemen employed in manufacturing establishments throughout the United States.

The paper, which contains descriptions of methods of firing soft coal under power plant boilers and of methods of handling fire so as to have the least smoke and to get the most heat from the fuel, seeks to meet the needs of the men, many without a technical education, who are employed in small plants of 1000 to 2000 hp. capacity. For this reason the language used is plain and simple, and technical terms have been avoided as far as possible.

Under "General Directions on Firing Soft Coal," the publication makes the following statements:

"When burning bituminous coal under power plant boilers, the best results are obtained if the fires are kept level and rather thin. The best thickness of the fires is 4 to 10 in., depending on the character of the coal and the strength of draft. The coal should be fired in small quantities and at short intervals. The fuel bed should be kept level and in good condition by spreading the fresh coal only over the thin places where the coal tends to burn away and leave the grate bare.

"Leveling or disturbing the fuel bed in any way should be avoided as much as possible; it means more work for the fireman and is apt to cause the formation of troublesome clinker. Furthermore, while the fireman is leveling the fires a large excess of air enters the furnace, and this excess of air impairs good efficiency.

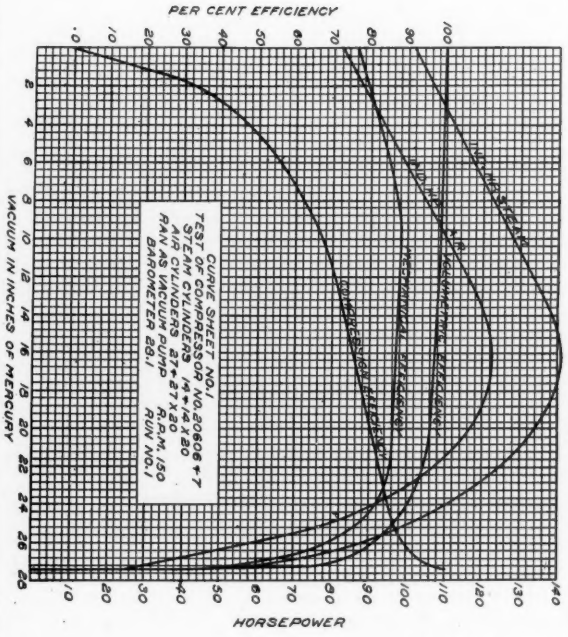
"The ashpit door should be kept open. A large accumulation of refuse in the ash pit should be avoided, as it may cause an uneven distribution of air under the grate. Whenever a coal shows a tendency to clinker, water should be kept in the ash pit. All regulation of draft should be done with the damper and not with the ashpit doors.

"In firing, the fireman should place the coal on the thin spots of the fuel bed. Thin and thick spots will occur even with the most careful firing, because the coal never burns at a uniform rate over the entire grate area.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

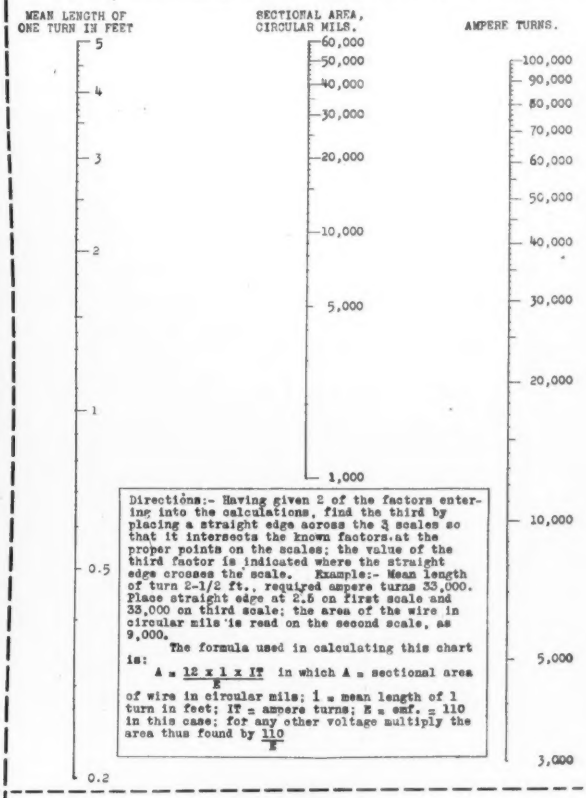
PRACTICAL ENGINEER


PER CENT EFFICIENCY
VACUUM IN INCHES OF MERCURY
HORSEPOWER
CURVE SHEET NO.1
TEST OF COMPRESSOR NO.20606 + 7
STEAM CYLINDERS 14 + 14 X 20
AIR CYLINDERS 27 + 27 X 20
RAN AS VACUUM PUMP 127 R.P.M. 150
BAROMETER 29.1
RUN NO.1

FRANK RICHARDS

PRACTICAL ENGINEER

CALCULATING CHART FOR WIRE ON A 110-V. MAGNET

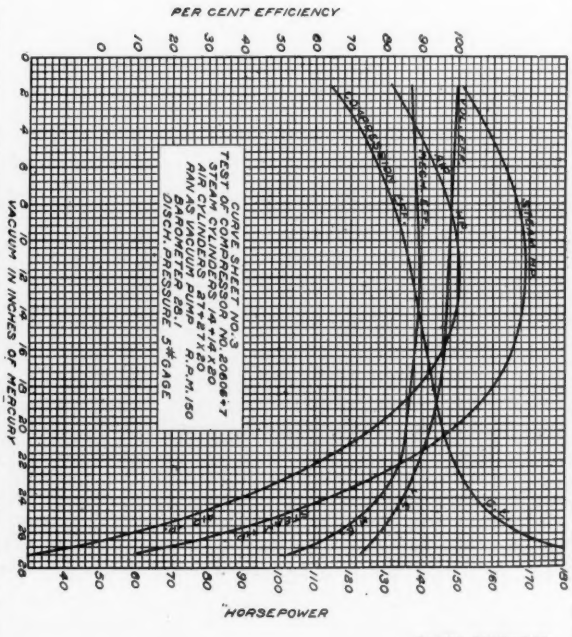


Directions:- Having given 2 of the factors entering into the calculations, find the third by placing a straight edge across the 3 scales so that it intersects the known factors at the proper points on the scales; the value of the third factor is indicated where the straight edge crosses the scale. Example:- Mean length of turn 2-1/2 ft., required ampere turns 33,000. Place straight edge at 2.5 on first scale and 33,000 on third scale; the area of the wire in circular mils is read on the second scale, as 9,000.

The formula used in calculating this chart is:

$$A = \frac{12 \times l \times IT}{E}$$ in which A = sectional area of wire in circular mils; l = mean length of 1 turn in feet; IT = ampere turns; E = emf. = 110 in this case; for any other voltage multiply the area thus found by $\frac{110}{E}$

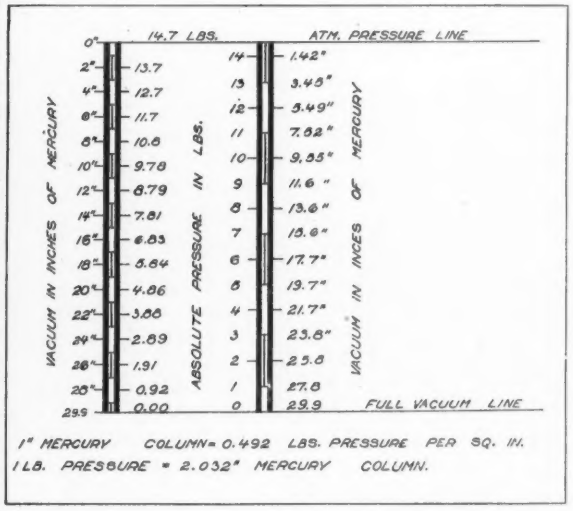
PRACTICAL ENGINEER


PER CENT EFFICIENCY
VACUUM IN INCHES OF MERCURY
HORSEPOWER
CURVE SHEET NO.3
TEST OF COMPRESSOR NO. 20606 + 7
STEAM CYLINDERS 14 + 14 X 20
AIR CYLINDERS 27 + 27 X 20
RAN AS VACUUM PUMP R.P.M. 150
BAROMETER 29.1
DISCH. PRESSURE 5# GAGE

FRANK RICHARDS

PRACTICAL ENGINEER

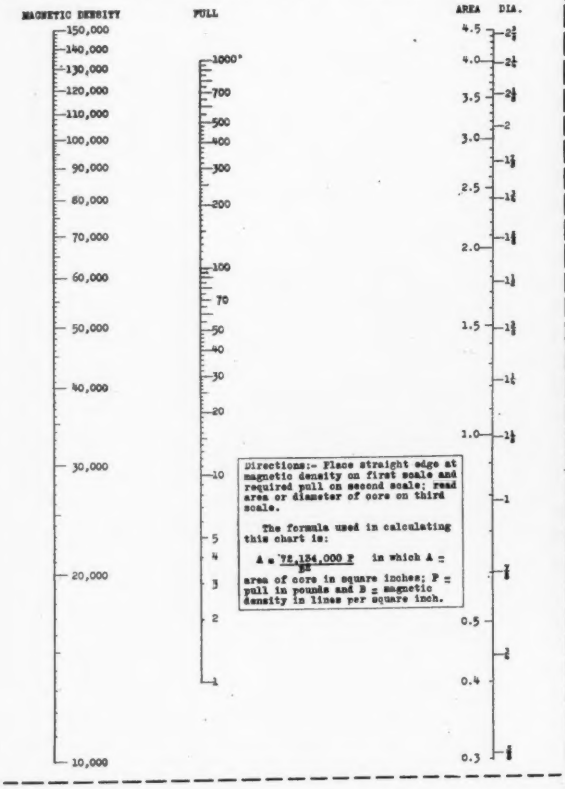
COMPARISON OF VACUUM AND ABSOLUTE PRESSURES AT SEA LEVEL

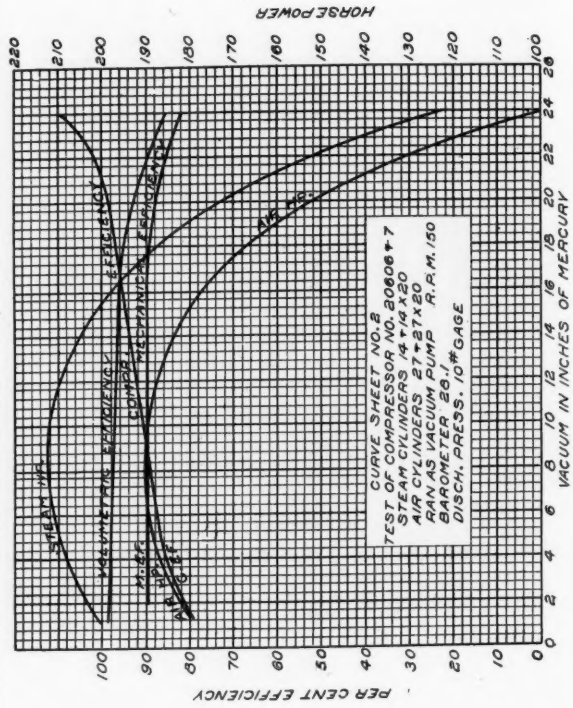


1" MERCURY COLUMN = 0.492 LBS. PRESSURE PER SQ. IN.
1 LB. PRESSURE = 2.032" MERCURY COLUMN.

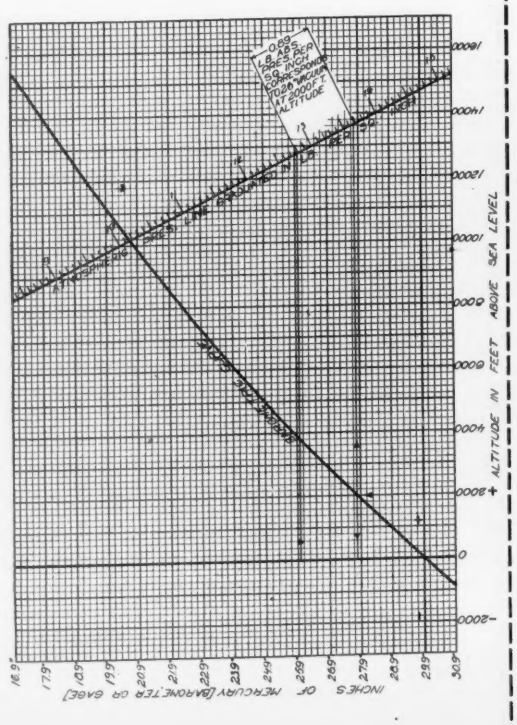
ERIC H. PETERSON

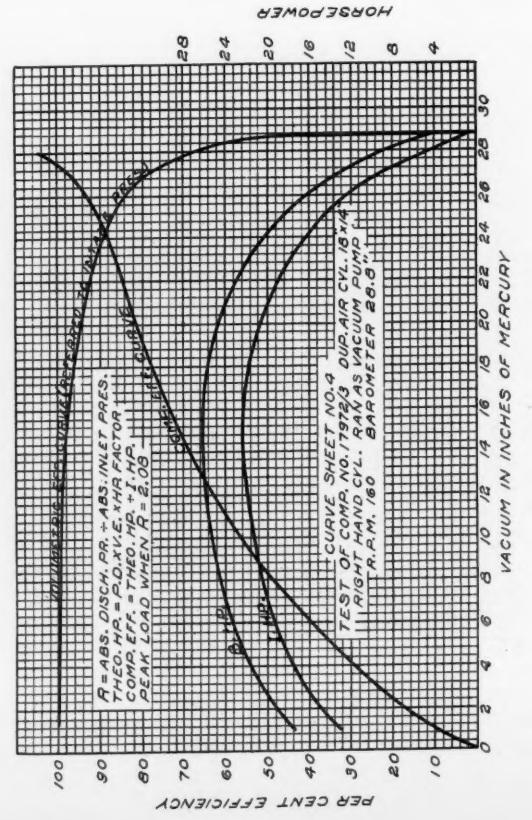
CALCULATING CHART FOR CORE OF ELECTRO MAGNETS


MAGNETIC DENSITY
PULL
AREA
DIA.
Directions:- Place straight edge at magnetic density on first scale and required pull on second scale; read area or diameter of core on third scale.
The formula used in calculating this chart is:
A = 72,134,000 P / B²
in which A = area of core in square inches; P = pull in pounds and B = magnetic density in lines per square inch.


HORSE POWER
VACUUM IN INCHES OF MERCURY
PER CENT EFFICIENCY
CURVE SHEET NO.8
TEST OF COMPRESSOR NO. 20806-7
STEAM CYLINDERS 14-14 x 20
AIR CYLINDERS 27-27 x 20
RAN AS VACUUM PUMP R.P.M. 150
BAROMETER 29.1"
DISCH. PRESS. .10# GAGE

RELATION BETWEEN BAROMETRIC HEIGHTS, ALTITUDES AND PRESSURES; ALSO SHOWING PRESSURE IN POUNDS ABSOLUTE CORRESPONDING TO INCHES OF VACUUM AT DIFFERENT ALTITUDES




HORSE POWER
VACUUM IN INCHES OF MERCURY
PER CENT EFFICIENCY
CURVE SHEET NO.9
TEST OF COMP. NO. 17972/3 DUP. AIR CYL. 18x14
RIGHT HAND CYL. RAN AS VACUUM PUMP
R.P.M. 160 BAROMETER 28.8"

In places where the air flows freely through the fuel bed the coal burns faster than in places where the flow of air is less. The cause of this variation in the flow of air through the different parts of the fuel bed may be differences in the size of the coal, accumulations of clinker, or the fusing of the coal to a hard crust. Where the coal burns rapidly, the thin places form.

"Before throwing the fresh coal into the furnace, the fireman should take a quick look at the fuel bed and note the thin spots. In a well-kept fire these spots can be recognized usually by the bright hot flame. The thick places have either a sluggish, smoky flame or none at all. In order to place the coal over the thin places the fireman should take a rather small quantity of coal on his scoop, for it is much easier to place the coal where it is needed with small shovelfuls than with large ones.

"The coal should be placed on the thin places in rather thin layers. If the fireman attempts to fill up the deep hollows in the fuel bed at one firing, the freshly fired coal may fuse into a hard crust, thus choking the flow of air, causing the fuel to burn slowly and starting new high places. If the high places in the fuel bed are missed on 1 or 2 firings, the hard crust at the surface will gradually burn through or crack, thus allowing more air to flow through, and the place will get back to its normal condition. Of course, if the high place in the fuel bed is caused by clinker, the flow of air will not be free until the clinker is removed with the fire tool. Whatever may be the cause of the high places in the fuel bed, the fireman should remember that they are places where the coal does not burn. There is no use in placing coal on such a place.

"If the firings are too far apart, the coal in the thin spots may burn out entirely, allowing a large excess of air to enter the furnace in streams. If those streams of air are not properly mixed with the gases from the coal, only a small percentage of the air is used for combustion and most of it passes out of the furnace, depriving the boiler of considerable heat. If, for instance, air enters the furnace at atmospheric temperature, say 75 deg. F., and leaves the boiler at about 575 deg. F., it carries away the heat that was absorbed in raising its temperature 500 deg. This heat is lost to the boiler. Another loss of heat occurs when holes form in the fuel bed, because pieces of unburned coal fall through the grate when the fireman attempts to cover the holes with fresh coal. Therefore, in order to avoid the formation of holes, firings should be made at short intervals, particularly if, for any reason, the fuel bed must be kept thin."

Copies of Technical Paper 80 may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

GEORGE WESTINGHOUSE, a Tribute, by Arthur Warren; 32 pages, with illustrations.

This booklet contains a sketch of the achievements and character of George Westinghouse, followed by a synopsis of the important events of his career. The honors conferred on the inventor by various institutions and foreign rulers are also mentioned, with the date of each.

Catalog Notes

COPES BOILER FEED regulators are described and illustrated in the 40-page catalog of Northern Equipment Co., Erie, Pa.

A CIRCULAR just published by Homestead Valve Mfg. Co., Pittsburgh, Pa., is being circulated among steam users and others interested in valves.

FROM H. A. ROGERS CO., 87 Walker St., New York, we recently received an illustrated folder on the subject of screw plates.

"S-C" VERTICAL FEED WATER regulator, a continuous graduated feed, is the subject of Bulletin No. 21, recently received, together with flow meter charts, from The "S-C" Regulator Co., Fostoria, O.

VENTILATION OF the Fletcher Savings and Trust Co. building, in Indianapolis, Ind., is described in a pamphlet just received. This building is equipped with the "Sirocco" system of heating and ventilating installed by American Blower Co., Detroit, Mich.

TAGLIABUE CO_2 THERMOSCOPE, to indicate the percentage of carbonic acid gas in flue gases, is described and illustrated in Bulletin 314 from C. J. Tagliabue Mfg. Co., 18-88 33rd St., Brooklyn, N. Y.

Bulletin 310, entitled "Instruments for Steam Plant Use," deals with thermometers, temperature controllers, pressure controllers, pyrometers, etc.

THE SORGE-COCHRANE hot process system of softening boiler feed water is described in a 20-page pamphlet lately issued by the Harrison Safety Boiler Works, 3144 North 17th St., Philadelphia. This process is based upon the fact that chemical reactions are more rapid and complete in hot water than in cold water, and the precipitates, less soluble and coarser, so that they settle more rapidly. In this system the heating and chemical treatment apparatus are combined, the heater portion being similar to the Cochrane open feed water heater. This booklet should be of interest to owners and operators of steam power plants.

WESTINGHOUSE ELECTRIC FANS, Dealers' Catalog, Section DS300, covers the entire line of Westinghouse fans for the year 1915. The catalog is profusely illustrated and gives in considerable detail the construction and operating features.

Westinghouse Railway Data Exchange, January, 1915, contains a reprint of an article from the Electric Railway Journal on "The Problem of Old Motors," also one by Elbert Hubbard on 3-cent fares. A number of views of the later type of Westinghouse motors are given together with their more important characteristics. An insulating varnish spray is also described, and a diagram given showing its method of application.

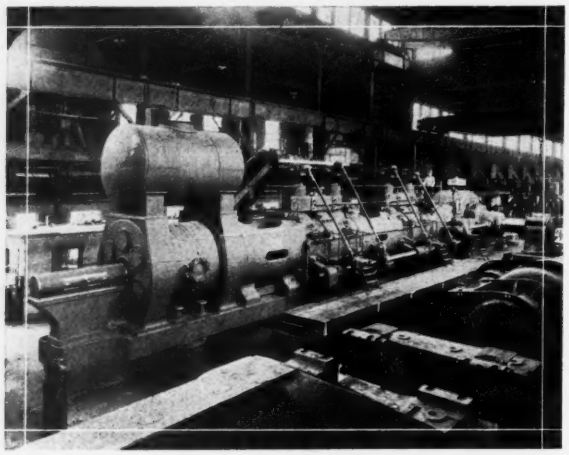
PIPE REPAIR Book, illustrating and describing steam joint clamps, pipe clamps, bibb reseaters, valve discs, etc., is being sent out by M. B. Skinner & Co., 558-562 Washington Boul., Chicago.

L. J. WING MFG. CO., 352-362 W. 13th St., New York, has issued a new bulletin, No. 27, describing the company's "Type E" turbine blower, etc.

Trade Notes

THE YARNALL-WARING CO., of Chestnut Hill, Philadelphia, has recently secured order for "Lea" V-Notch meters from the Philadelphia Electric Co., for its great new Christian St. power house, for what is believed to be the largest feed water V-Notch metering installation in the world, comprising 2 800,000 lb. per hour "Lea" V-Notch recording meters combined with 2 20,000-hp. Webster feed water heaters and purifiers, to heat and measure 20,000 b.hp. of feed water. Make-up water for this plant will be measured by a 175,000-lb. per hour "Lea" V-Notch recording meter.

THE ACCOMPANYING illustration shows one of the largest single tandem gas blowing engines ever constructed in the United States, on the erecting floor of the Mesta Machine Co., and gives a good idea of how the engine will appear when finally erected at the plant of the Pennsylvania Steel Co., Steelton, Pa., because the platform in the foreground is approximately at floor level relative to the engine. The gas cylinders are 46 in. in diameter, the air cylinder 84 in. in diameter and the stroke 60 in. The engine will run at a speed from 45 to 85 r.p.m., depending upon operating conditions.



The air end is equipped with automatic plate valves which require no valve gearing, the use of these valves being made possible by placing the air cylinder directly back of the gas cylinders so that the air cylinder piston can be directly driven through an extension of the gas cylinder piston rod. The engine is of the center crank type, permitting the use of double bearing bed plate to give equal distribution of the stresses.

THE LEA-COURTENAY line of turbine and volute pumping machinery has been handled in the Chicago territory for several years by Maher & Byrne Co., Otis Bldg. Owing to an increase in the business, it has been found advisable for the company to open its own Chicago branch. Mr. Maher resigned from Maher & Byrne Co. on Jan. 1, and now becomes associated with the Lea-Courtenay Co. as its Chicago manager, with offices in the Conway Bldg., telephone Franklin 4274-5.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By able bodied man of 31, married, assistant in hydro-electric plant; 4 yr. experience in station practice, 3 yr. in charge. Also 4 yr. experience as oiler on large lake boats. Address Box 388, Practical Engineer, Chicago, Ill. 3-15-1

POSITION WANTED—As chief engineer of large central station. Have had unlimited experience in the erection, operation and management of power plants. Thoroughly familiar with gas power apparatus. Practical draftsman. Hold Pittsburgh and Buffalo license. Can furnish best of references from several of the largest concerns in the country. Address Box 389, Practical Engineer, Chicago, Ill. 3-15-1

POSITION WANTED—Experienced engineer who understands both theory and practical operation of generators, steam and gas engines, and water purification, with technical education and 9 yr. practice in all lines, desires position in Middle West. Will furnish best of references, including present employer. Address Box 383, Practical Engineer, Chicago, Ill. 3-1-2

POSITION WANTED—Graduate in electrical engineering 1914, desires work with some power and light company or electrical contractor. Have had some experience. Can give best of references. Address Box 207, L. T. P., Wilsonville, Nebr. 3-1-2

POSITION WANTED—In modern plant where knowledge may be acquired. 3 yr. experience as fireman, oiler and switchboard operator. I. C. S. student. 30 yr. of age; married; abstainer and dependable. F. W. Beecroft, 3216 Fulton St., Chicago, Ill. 2-15-2

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 3-1-1

POSITION WANTED—As assistant engineer; experienced; I. C. S. student; best references; strictly sober; hold first-class license; will consider small salary if advanced as merited. Address Robert Pieper, Blooming Prairie, Minn. 3-15-1

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 2-15-2

POSITION WANTED—By engineer with 10 yr. experience on Corliss and slide-valve engines, horizontal and vertical water tube boilers. Age 40 yr. Address Ed Larson, Aetna, Ind. 3-1-2

POSITION WANTED—As Chief Engineer in a hotel, office building or manufactory. Experienced in power refrigeration and hydraulics. Address Box 386, Practical Engineer, Chicago. 3-1-2

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 3-15-1

Wanted

WANTED—Resident subscription agent in the following cities: Atlanta, Ga., Baltimore, Md., Cincinnati, Cleveland and Columbus, Ohio, Denver, Colo., Detroit, Mich., Kansas City, Mo., Los Angeles, Calif., Louisville, Ky., Minneapolis, Minn., Newark, N. J., New Orleans, La., Philadelphia, Pa., Portland, Ore., St. Louis, Mo., St. Paul, Minn., San Francisco, Calif., Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Agents to sell my Graduated Calipers, Pocket Levels, etc. Liberal commission. Ernst G. Smith, Tampa, Fla. 2-1-6

Help Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Sales Engineer. Successful concern, established eighteen years, highest standing in its line in the United States, wants a Sales Engineer. Only first-class salesmen having had experience in engineer lines considered. Our product a necessity in every boiler plant. Price averages $250 per boiler. Sold on absolute guarantee. Exclusive territory allotted. Cash advances on trial orders will finance you if you have the ability. Positively give details about yourself in first letter. All correspondence held strictly confidential. Address Box 391, Practical Engineer, Chicago, Ill. tf.

SALESMEN WANTED—Experienced, in every large city and territory to handle Vacuum Traps and High Pressure Expansion Traps. State full particulars in answer. Address Box 387, Practical Engineer, Chicago. 3-1-2

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—Machinery. All sizes new and second-hand Pulleys, Belting, Shafting, Hangers, Couplings, Pillow Blocks, Collars, etc. Passman Bros., 28 and 30 So. Green St., Chicago, Ill. 3-15-6

FOR SALE—Specials: 10x24 Allis Corliss engine, overhauled, $375. Three 72 in. by 18 ft. HRT boilers, 150 lb. steam pressure, 2 yr. service, $400 each. 500-hp. Haine water-tube boiler, 6 yr. service, 150 lb. steam pressure, $1675. 75-kw. Northern 230-volt generator, direct-connected Erie Ball engine with switchboard, $1000. Duzets & Son, 50 Church St., New York. tf.

CARR VENTILATED FURNACE ARCH for all types of boilers and furnaces, gives 100 to 400 per cent greater service than any other kind. Write for information, giving number and kind of boilers and furnaces. Elmer E. Carr, 231 Insurance Exchange Bldg., Chicago, Ill. 3-1-3

FOR SALE—Steam Hammer, 750-lb. Bement Niles; excellent condition; will sacrifice to move quick. Have large stock machinery of all kinds. Send us your inquiries. Zelnicker Supply Co., St. Louis, Mo. tf.

FOR SALE—10x12, steam-driven air compressor, designed for high pressure work on air or gas. Write for details. Lucas & Son, Bridgeport, Conn. 3-1-2

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather. tf.

Micellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

The Buy-It-Now Campaign

As the glacier precipitated from the mountain top gathers velocity and weight in its downward plunge, so likewise is the *Buy-It-Now* Campaign, inaugurated a short time ago, receiving added force and support from day to day.

Factories, shops, railroads and public utilities are awakening to the realization that it is the right plan for stimulating business activity. Every individual should support such a movement, the logic and saneness of which are indisputable.

As a business proposition it is as simple as 2 and 2 make 4, and proves itself just as easily.

This is the result in a nutshell:—

If all those who need to buy and have the wherewithal, purchase what they really need, business would receive a powerful boost and a greater prosperity, nourished by "the fat of the land," would sweep the country.

Buy-It-Now does not mean to practice false economy and stock up on a lot of needless goods because of a low price, but it *does mean* to *Buy Now* with advantage to yourself, and for the good of the country anything you will need for future business or personal progress, comfort or luxury.

Surely that is exerting a patriotism beneficial to mankind.

This is putting the problem purely, simply and squarely up to each individual, whether producer or consumer, to "work out his own salvation"—to help himself and others to bring about a general prosperity.

How irrational for the producer and consumer to "draw their purse strings tight"—tie them in a double knot and wait upon the slow, uncertain and mysterious deliberations of Congress—of investigating committees—of diplomatic negotiations, etc.

Figuratively speaking, that is "killing the goose that laid the golden egg."

The *Buy-It-Now* movement offers individual opportunity to "take the bull by the horns", and resist a stampede that no amount of legislation or committee-findings could avoid when the individual restrains himself by an indefinable fear concerning the finances of the "butcher, the baker, the candle-stick maker."

Let us quote the editor of Practical Engineer:

* * * "Granting that by greater activity and volume of buying, business would be improved, if everybody who needs goods or will need them within a short time, and who can well buy them now, would do so at once, even though the individual orders be not large, the total increase in business would go a long way toward bringing greater prosperity to the country."

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"What work is there in your plant which ought to be done, and can well be done at once? What personal and family needs must be met soon which can as well be supplied at once? If every man will consider these questions seriously and act accordingly, he will have done his part, and the resulting business improvement will react to his benefit. Waiting for the other fellow to start first never gets anybody anywhere."

The plan is simple, sure and speedy, and ought to be practiced to the full measure of its worth. Of course, the thing to do is to buy advertised goods, and be assured of the judicious expenditure of your money. Furthermore, let us give credit to all advertisers, for it is they who are doing so much to make this *Buy-It-Now* campaign a success.